Progress Report PTR-1043 77-4
Contract No. MDA903-77-C-0039
For the Period October 1, 1976 to March 31, 1977
April 1977

COMPARATIVE STUDIES OF ORGANIZATIONAL FACTORS IN MILITARY MAINTENANCE

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NOTES

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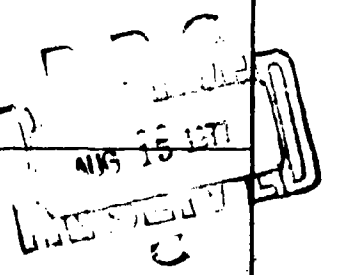

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This report describes a comparative analysis of organizational factors in maintenance. The analysis involves an investigation and comparison of U.S. military and U.S. civilian maintenance organizations, as well as Israeli military maintenance practices. →

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The report includes: (1) an overview of the program, including a statement of the problem, background, objectives and technical approach; (2) the description and formalization of a model of incentives and organizational effectiveness, a review of the psychological literature concerning the effects of organizational factors on maintenance personnel productivity and satisfaction forms the foundation of the effectiveness model; and (3) the findings of a preliminary maintenance systems analysis, which compares U.S. military and U.S. civilian maintenance practices. The next phase of work will focus on developing and administering questionnaires and interviews for obtaining detailed comparisons of military and civilian maintenance practices. An analysis of Israeli military practices will also be completed in the next work phase.

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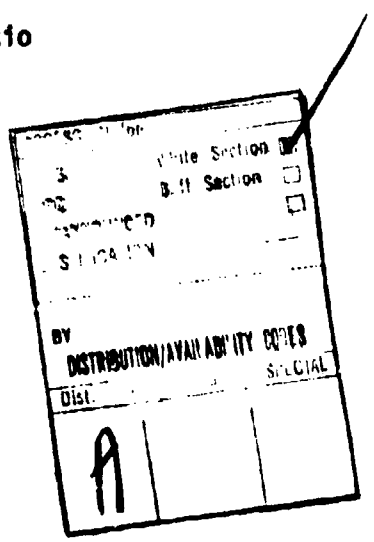

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1. SUMMARY

1.1 Report Period

The first six months of contract activity involved establishing contact and meeting with several military and civilian helicopter maintenance organizations, performing computer-based literature reviews of organizational influences of maintenance personnel productivity and satisfaction, developing a model of organizational incentives and effectiveness, and initiating a plan for acquiring comparative field data on organizational incentives and policies for military and civilian maintenance organizations. The following specific tasks were accomplished during the past six months.

(1) Site visits were made to military and civilian maintenance organizations to obtain first hand overviews of their structure, operating procedures, incentive programs, and effectiveness. The site visits were also used to obtain support and cooperation from the various maintenance organizations, and to determine the amount and type of data that could be obtained through interviews, questionnaires, and from maintenance reports.

(2) Computer-based literature reviews were performed to identify organizational factors that have been found to affect maintenance personnel performance and satisfaction, and to identify measures of individual and system perofrmance. A review of the effectiveness of incentive programs in military maintenance units was also performed.

(3) A model of organizational incentives and effectiveness was developed to, (a) structure the organizational analysis (b) delineate important organizational factors, (c) provide a framework for constructing data collection instruments, and (d) provide a structure for organizing and reporting the comparative field data collected during this study.

(4) An analysis plan for obtaining the data required for evaluating the effectiveness of military and civilian maintenance organizations was begun. The analysis includes the determination of what data should be obtained, what personnel and organizations have to be surveyed to obtain the required data, and how to collect the required data. The information obtained in the three activities listed above provide the inputs for developing the analysis plan.

1.2 Next Period

The contract activity during the third quarter will concentrate on acquiring comparative field data for military and civilian maintenance organizations. In addition, an analysis of Israeli maintenance practices will be performed. The specific items of work for the next period include:

(1) Select a representative sample of military and civilian organizations in which to acquire the needed comparative field data.

(2) Identify the personnel to be surveyed.

(3) Develop the data collection instruments.

(4) Acquire the comparative field data.

(5) Survey and describe Israeli maintenance practices.

1.3 Program Plan and Schedule

A program review chart for the present year's effort is shown in Figure 1-1. The chart shows the interdependencies and the expected completion time for each program milestone. The numbers over the milestone box are used to identify the milestones. The milestones are arranged in chronological order. Milestone descriptions are contained in Appendix A.

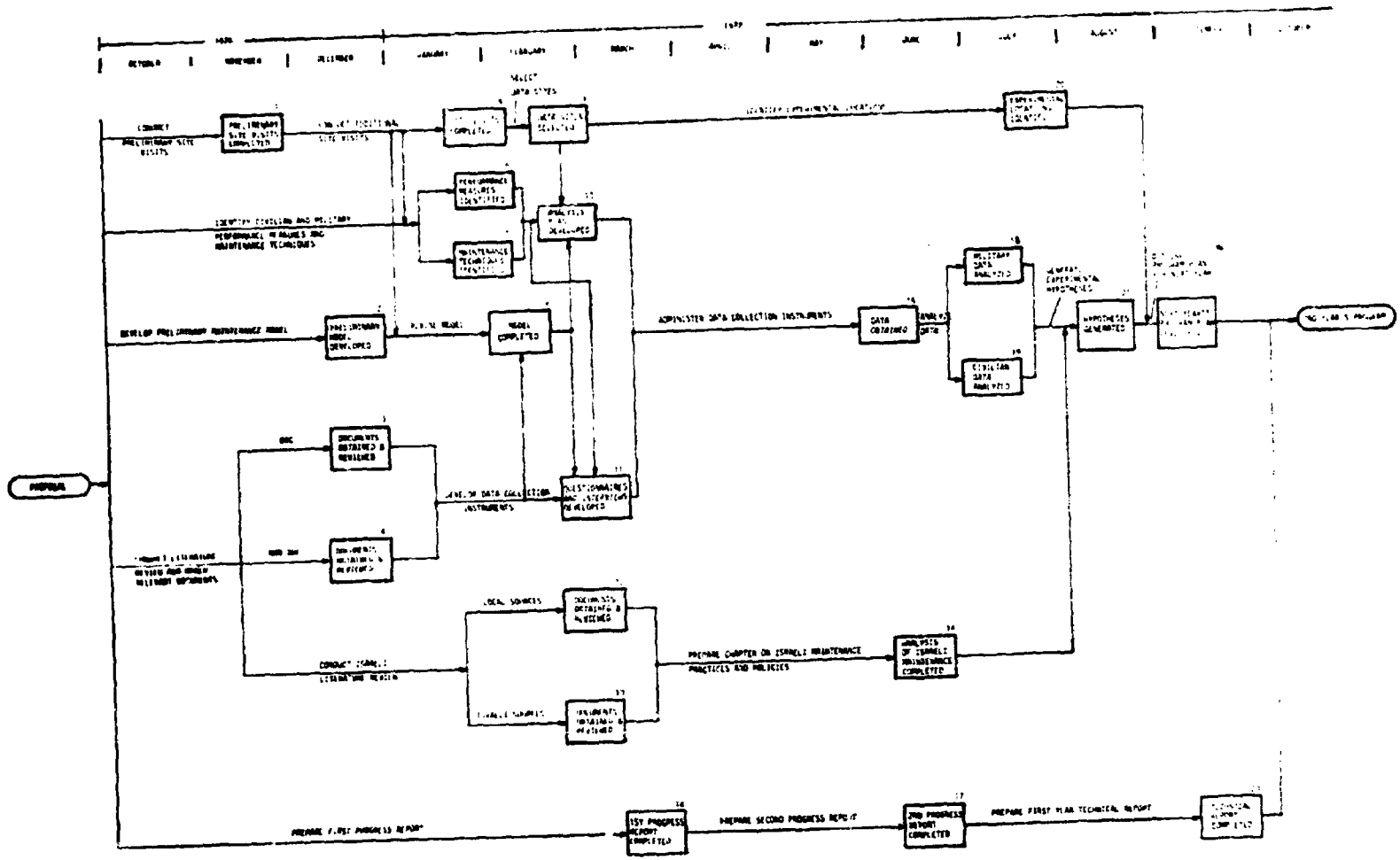

FIGURE 1. PROGRAM SCHEDULE

2. PROGRAM OVERVIEW

2.1 Statement of Problem

During the past two decades, military maintenance has become a problem of tremendous proportions, with costs accounting for up to one-fourth of Department of Defense budgets (Smith, et al, 1970). It is well recognized that current systems of military maintenance fall far short of optimum performance. Even where maintenance is effective, in the sense of keeping equipment operational, it is inefficient, in terms of personnel, material, and time.

A major contributing factor to the increase in maintenance costs is the complexity of modern military equipment. To many, it seems that the rapid growth in complexity has outstripped the ability of the system to prepare and orient maintenance personnel. As a result, virtually all recent attempts at improving maintenance have focused on two areas: (1) improving technician skills, primarily through training, and (2) providing on-the-job aids, primarily manuals and other technical devices (King and Duva, 1975). Research and development in these areas has emphasized new types of equipment, and there has been only a limited effect on maintenance system performance (Bond, 1970). It appears that if a breakthrough is to occur in the maintenance problem, it will have to come from another direction. An approach of considerable promise is that of investigating viable incentive structures and organizational policies as they relate to maintenance effectiveness.

2.2 Background

A major reason for the previous lack of payoff in maintenance research and development is a relative neglect of important organizational factors. For instance, Foley (1975) has pointed out that "methods used to

select, train, and promote maintenance personnel (in themselves) contribute to inefficient maintenance." Attention to organizational effectiveness, which includes such factors as management policies, incentive structures, and inter-personnel relations, in addition to training programs and task design, has caused significant improvement in other organizational contexts (Zawacki, 1974). Attention to organizational policies and procedure may be a highly promising means of improving the cost-effectiveness of military maintenance.

Active R&D programs in organizational effectiveness are presently being supported by ONR, ARI, and Air Force groups. Individual studies within these programs deal with the analysis of organizational interactions, with their effects on group and individual performance, and with the dynamics of organizational change. These studies provide a useful reference source for the present project. In addition, the methodology of organizational development (OD), which focuses on the behavioral aspects of management practices, may also offer insights into important areas for comparative examination.

Improvements in system effectiveness due to organizational modifications have been previously demonstrated in a large number of cases. For example, Vroom (1964) and Lawler (1971) provide extensive reviews of the literature showing that when organizational policies, incentive systems, and work situations are structured to make reward (both intrinsic and extrinsic) contingent upon performance, increases in productivity, job attendance and motivation result. Similarly, Porter and Lawler (1965) reviewed much of the then current literature regarding the effects of organizational structure on worker attitudes and performance. Variables such as span of control, work shop site, and tall or flat organizational structure, were shown to be related to productivity, job satisfaction, absenteeism, and turnover.

In the area of organizational development, Hitchcock and Sanders (1974) found strong relationships between various dimensions of organizational climate/management practices and the criterion of accidents among munition workers. Goal setting, as an organizational practice, has also been shown to improve job performance (Latham and Kinne: 1974), while Lawler (1969) found evidence of increased productivity in 6 out of 10 studies which redesigned jobs to increase intrinsic motivation. Ford (1969) reported a 27% reduction in turnover through such efforts; and Bowers (1973), studying 23 civilian organizations, demonstrated the effectiveness of OD in improving decision making performance. The research evidence, then, overwhelmingly supports the contention that organizational policies and practices have direct and significant effects on personnel performance and organizational effectiveness.

2.3 Objectives

The objective of this program is to systematically identify, investigate, and analyze organizational factors and incentive structures which impact on military maintenance effectiveness and efficiency. This will be accomplished by performing an in-depth analysis of military, civilian and Israeli maintenance organizations. The civilian and Israeli sources will provide comparisons from which testable hypotheses will be generated. These hypotheses will be aimed at improving military maintenance.

A secondary objective, although one which may have wide application, is to document the "investigative reporting" methodology which will be followed to uncover, and trace through the organization, those factors and practices which appear to aid or hinder maintenance effectiveness and efficiency.

The specific objectives of the present program include the following:

(1) Survey and categorize the critical organizational and interpersonal factors which control the ability of a military maintenance system to deliver effective and efficient maintenance. Select and/or devise measures of maintenance system performance and of relevant personnel attitudes.

(2) Establish a suitable format and methodology for investigation of primary organizational factors in military and civilian maintenance settings, with an emphasis on incentives.

(3) Investigate a selected number of military and civilian groups maintaining an equivalent high technology system to acquire, by questionnaire and interview, comparative field data on maintenance organizational goals, structure and function, support structure, incentives, and personnel attitudes, as well as the cost effectiveness of maintenance.

(4) Organize and analyze the field data so as to permit (a) direct comparison among U.S. systems, (b) identification of the key organizational factors contributing to good and bad system performance, and (c) selection of recommended organization approaches for subsequent experimentation.

(5) Plan, conduct, and analyze experimental investigations of recommended new organizational approaches to evaluate their effectiveness in U.S. military settings.

(6) Use sources of information available in the U.S. to collect data on equivalent organizational factors in the Israeli military maintenance structure. Compare these data with the U.S. data as an aid to objective (4). Devise a methodology and program plan for more detailed examination of foreign maintenance practices in a U.S. setting, to include: (a) the present effectiveness of divergent procedures on similar equipment, and (b) the potential effectiveness in the U.S. setting of innovative approaches based on outside practices.

(7) On the basis of the experimental and analytical results, formulate guidelines and specific recommendations for the improvement of maintenance system performance.

2.4 Approach

2.4.1 Organizational Comparisons. The general problem of improving maintenance effectiveness exists in civilian organizations as well as in the military, and in foreign military organizations as well as in our own. It appears that valuable additional insights into the role of organizational factors can be gained by examining differences and similarities in these various environments. In particular, the military organizational structure exemplifies a "tall" organization, with many hierarchical, well-defined management levels. In contrast to civilian organizations, one can expect more formalized communication, less lateral interactions, and less emphasis on flexibility, innovation, and individual initiative. As a result, comparative examination of military and civilian groups doing essentially the same maintenance job can provide valuable insights regarding the importance to maintenance system performance of:

(1) Incentive structures

(2) Lines of authority

(3) Communications channels

Since military and civilian organizations differ in other ways as well (i.e., in their goals), it would also be useful to compare two military systems with similar goals, but different operating environments. Essentially, this means a comparison between U.S. military maintenance, and maintenance as performed by some foreign military is desirable. In surveying potential foreign military organizations for this type of comparison, attention is drawn to the case of Israel. Israel represents a highly modern military, which uses much U.S. equipment, but which operates in a quite different manner with regard to manpower selection, manpower mobilization, and general response posture.

Preliminary analysis indicates that while there are many similarities between U.S. and Israeli maintenance practices, the differing conditions of external threat, of material and human resources, and of social outlook have led the two countries to establish maintenance systems with somewhat different orientations and capabilities. At the risk of oversimplification, one can hypothesize that the strong point of the U.S. system is its provisions for parts supply and constant preventative operations, leading to a relatively high level of steady-state equipment readiness. At the same time, the strong point of the Israeli system is its high degree of responsiveness and initiative, leading to a capability for fast turnaround, quick repair of field equipment under combat conditions, effective use of a varying and diverse manpower supply, and efficient maintenance of unfamiliar material (such as captured Soviet equipment). A model for the hypothesized difference between U.S. and Israeli maintenance effectiveness is shown in Figure 2-1.

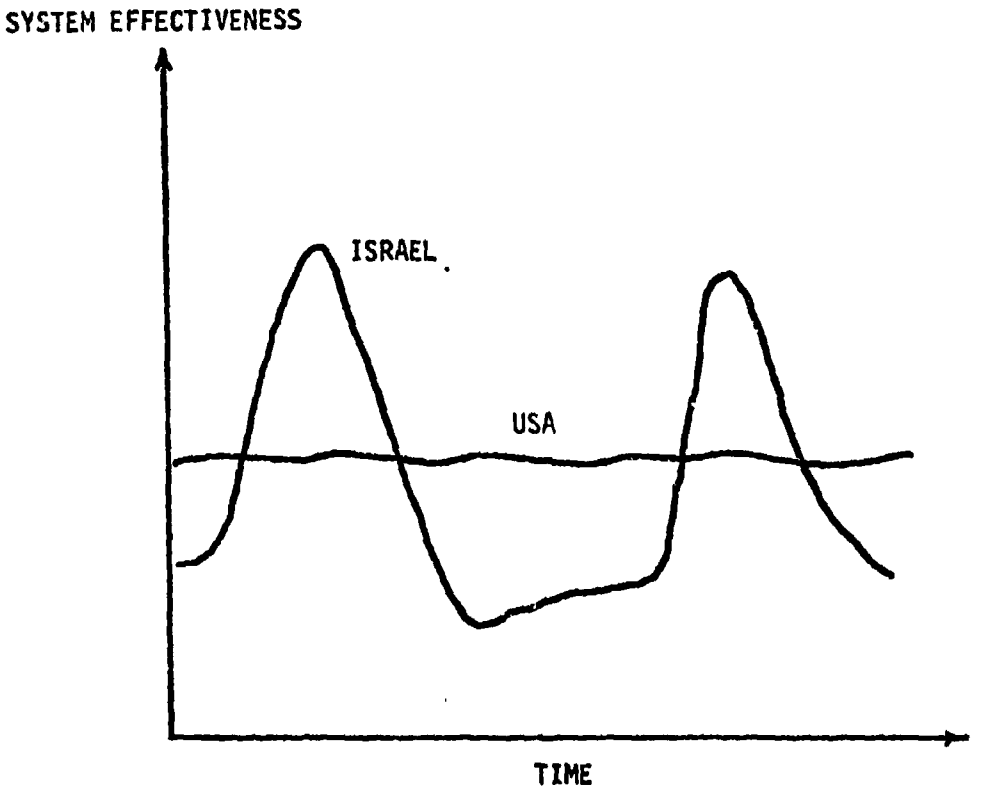

FIGURE 2-1. HYPOTHESIZED MODEL OF MAINTENANCE SYSTEM EFFECTIVENESS

It appears that the U.S. and Israeli systems complement each other, and that as a result, there is a good potential for identification of innovative approaches from Israeli experience. Accordingly, Israel was selected for purposes of generalized inter-military organizational comparison during the first-year program effort.

2.4.2 Data Acquisition. The approach followed in this project for collecting comparative data is one of an investigative reporter. U.S. civilian and military maintenance organizations will be critically evaluated in order to isolate factors which could be, by their presence, hindering military maintenance efficiency, or, by their absence, not helping efficiency. It is anticipated that the analysis of civilian operations and Israeli data will generate hypothesis that may have been overlooked if only military installations were investigated.

The investigative reporter model involves essentially following inefficient practice up through the organization in an effort to discover why those certain practices are as they are. This can be contrasted with the typical organizational analysis which is usually content to just describe the presence of the factor. In essence, the approach will be to "pick up a string and follow it to its end". For example, if it is discovered that maintenance personnel are called off their jobs unpredictably to perform other duties such as burial detail, then this will be traced to its source. Who assigns the men to other duties? Why are maintenance men selected rather than another less critical classification? Can assignments be made more predictable? Etc.? Such questions require moving through, and up, the organization from level to level in and effort to uncover the rationale (or lack of it) that fosters the inefficient procedure.

Surveys and interviews of military mechanics and their supervisors will serve as the primary data for isolating inefficient procedures, each of which will be followed up by interviewing appropriate personnel in an effort to "tract the string". Surveys and interviews of civilian personnel installations will serve to identify procedures and factors which might improve efficiency in the U.S. military. Each of these will be traced through the military in an effort to document why the military does not, or cannot, do them.

It will not be possible, within the present scope of this project, to survey and interview Israeli military personnel. At this stage, information concerning Israeli military policies and practices will be gathered through an exhaustive review of Israeli and U.S. source literature dealing with Israeli military policies, practices, etc. Any insights emerging from this effort will be used to insulate potential factors to be explored during the U.S. military data collection efforts.

2.4.3 Defining Organizational Effectiveness. It is anticipated that, in the military, maybe more so than in civilian operations, different levels of the organization may have different criteria or models of how to define organizational effectiveness. It is possible, for example, that as we move up the organization, global criteria, such as availability of helicopters, become more important than specific criteria, such as turnover among personnel, waste (good parts replaced) or down time. These differences in definition and criteria may account for why certain procedures and factors exist. In essence, something may exist because it is not considered inefficient by a particular definition of organizational effectiveness. An attempt will be made to "capture" the models or definitions of effectiveness of various people at different levels of both civilian and military organizations.

2.5 System Selection

In order to focus the specific comparative examination of U.S. military and U.S. civilian maintenance organizations, initial selection was made of a system maintained by both groups. The basic requirements on candidate systems were that they be used in the same, or nearly the same, form by the U.S. military and by U.S. civilian organizations. Complete systems were favored over components. It was also desired that the systems be used in combat, be representative of modern mechanisms, both electronically and mechanically, and have some degree of criticality in use, so as to provide motivation for proper maintenance.

Table 2-1 summarizes an analysis, on the basis of eight selection criteria, of six systems which met the basic requirements outlined above. The six systems were:

(1) Light Aircraft (Cessna, Piper, etc.)

(2) Transport Aircraft (707, C-130, etc.)

(3) Light Helicopter (Bell, Hughes, etc.)

(4) Heavy Helicopter (Sikorsky, Boeing, etc.)

(5) Ground Transport (Trucks, Buses, Jeeps, etc.)

(6) Support Equipment (Ground Checkout, Computers, etc.)

Systems were judged on a scale of 1 to 5 for each criterion; 1 was poor and 5 was excellent. The standard was suitability for the purposes of this study. The analysis indicated that aircraft systems were superior

TABLE 2-1. EVALUATION OF SYSTEM CHARACTERISTICS

	LIGHT PLANE	TRANSPORT PLANE	LIGHT HELI	HEAVY HELI	TRANSPORT VEHICLE	SUPPORT EQUIP.
1. No. in Service	4	2	4	3	5	3
2. System Size	4	2	5	3	4	3
3. Subsystems	4	5	5	5	2	2
4. Use Frequency	3	3	5	4	3	2
5. Use Criticality	4	5	5	5	2	2
6. Downtime Criticality	4	5	5	4	2	3
7. Maintenance Criticality	3	5	5	5	3	3
8. Maintenance Records	5	5	5	5	3	2
Total	31	32	39	34	24	20

to the others, that helicopters were superior to airplanes, and that the light helicopter had the most favorable characteristics overall.

Table 2-2 is a listing of current U.S. rotary wing aircraft, as published in Aviation Week and Space Technology, March 17, 1975. For the light helicopters listed, the Bell Model 206 Series JetRanger appeared to best fit the criteria listed in the above analysis. This is a highly versatile craft, used by many civilian companies and organizations, as well as by the U.S. Military, and hardware modifications across users are minor. The Israel Defense Forces also use the JetRanger as a general-purpose transport aircraft. Following this analysis, the JetRanger was selected as the focal system for the maintenance program.

The JetRanger Helicopter is a single-crew, 4 to 5-place helicopter powered by an Allison turbine engine. It weighs about 3,000 pounds, has a maximum speed of 120-140 kts, and climbs to 20,000 feet in the civilian version. For the purposes of the present study, it is found in three main configurations:

(1) Model OH-58A Kiowa. Figure 2-2 shows the Army's version of the JetRanger. The OH-58A is used as a light observation helicopter, as well as for transport and as a utility vehicle. It can also carry the XM-27E gun system with 2,000 rounds of ammunition. About 2,200 are in service throughout the Army. They are maintained by military personnel.

(2) Model 206B JetRanger. This is the civilian version, pictured in Figure 2-3. There are more than 5,000 in use in over 50 countries. It is used as an air taxi, executive transport, police aircraft, ambulance, and all-around utility vehicle. Maintenance is independent or by Bell Helicopter.

TABLE 2-2. U.S. ROTARY WING AIRCRAFT

Manufacturer and Address	Model number	DOD designation	Popular name	GENERAL: Number in crew	GENERAL: Number of passengers	DIMENSIONS: Rotor diameter, ft.	DIMENSIONS: Maximum length, blades unfolded, ft.	DIMENSIONS: Maximum height, ft.	WEIGHTS: Empty weight, lb.	WEIGHTS: Normal gross weight, lb.	POWERPLANT: Number, make & model	PERFORMANCE: Max. speed, mph.	PERFORMANCE: Hover ceiling in ground effect, ft.	PERFORMANCE: Still-air range, mi	REMARKS
Bell Helicopter Co. Ft. Worth, Tex.	203A-1			1	14	44.2	57.1	14.4	5,855	9,500	1 Lyc. T53-13A ts.	127	10,400	317	
	204B		Jetranger 2	1	4	33.3	38.9	9.7	1,658	3,200	1 All. 250-C20 ts.	140	11,300	315	
		UH-1H	Iroquois	2	11	44.2	57.5	14.5	5,210	9,500	1 Lyc. T53-L-13 ts.	127	13,400	249	Succeeds UH-1D.
		UH-1N	Twin Huey	2	13	48.2	57.4	14.4	6,003	10,500	2 UACL T400-CP-400 ts.	116	12,900	203	USAF missile support. Also USN and USMC.
	212			2	13	48.2	57.3	14.4	6,827	11,200	2 UACL PT6T ts.	126	14,700	278	
		OH-58A	Kiowa	2	2	33.3	41.0	9.6	1,861	3,000	1 All. T63A-700 ts.	138	10,600	320	Army LOH.
	206L		Long Ranger	1	6	37	35.9	9.7	1,984	3,900	1 All. 250-C20B ts.	150	7,500	344	
	209	AH-1G	Cobra	2		44.3	53.1	13.6	6,601	9,500	1 Lyc. T53-L-13 ts.	219	9,900	393	Fire support vehicle.
		AH-1Q	Cobra	2		44.3	53.1	13.6	6,801	9,500	1 Lyc. T53-L-13 ts.	175	9,900	349	Armed w/TOW missiles.
		AH-1R	Cobra	2		44.3	53.1	13.6	6,900	10,000	1 Lyc. T53-L-703 ts.				Improved Fire Support Vehicle.
		AH-1S	Cobra	2		44.3	53.1	13.6	6,900	10,000	1 Lyc. T-53-L-703 ts.				Improved TOW launcher.
		AH-1J	Sea Cobra	2		44.3	58.5	13.7	6,372	10,000	2 UACL T400-CP-400 ts.	175	12,450	375	USMC Fire Support.
		AH-1J+	Sea Cobra	2		44.3	58.0	14.0	7,075	14,000	2 UACL T400-CP-402 ts.	175		270	TOW-capable vehicle for USMC/Iran.
	214A			2		50.0					1 Lyc. LTC-4B-8E ts.				For Iran. 214B is civil version.
	222			2	6		39.7	11.1	5,070	8,700	2 Lyc. LTS-101-650C	175			IFR capability planned.
	301	XV-15		2						15,000	2 Lyc. T53 ts.	275			Tilt-rotor for NASA/Army
		YAH-63	AAH	?							2 GE T700 ts.				Prototype attack helicopter.
Enstrom Corp. Menominee, Mich.	F-28A		Executive	1	2	32.0	29.0	9.1	1,450	2,150	1 Lyc. HIO-360-C1A re.	112	5,600	225	Guardian I police version.
	Model 280		Shark	1	2	32.0	29.0	9.1	1,450	2,150	1 Lyc. HIO-360-C1A	117	5,600	247	330 mi range with 60 gal. tanks (opt.)
	Model 280		Turbo-shark	1	2	32.0	29.0	9.1	1,490	2,250	1 Lyc TIO-360 tc.	120	10,000	247	330 mi. range with 40 gal. tanks (opt.)
Gyrodyne Co. of America St. James, N.Y.		QH-50D		0	0	20.0	20.0	9.9	1,035	2,328	1 Bo. T50 BO-12A ts.	92	10,300	161	Army research vehicle.
Hughes Helicopters Div. of Summa Corp. Culver City, Calif.	300C			1	2	26.4	30.6	8.7	1,039	1,900	1 Lyc. HIO-360-D1A re.	104	8,900	243	Law enforcement/utility.
	369A	OH-6A	Cayuse	1	4	26.3	30.2	8.5	1,163	2,550	1 All. T63-A-5A ts.	150	8,200	350	National Guard use.
	369			1	6-7	26.3	30.2	8.5	1,066	2,550	1 All. 250-C18A ts.	150	8,200	377	Executive utility.
	369M			1	4	26.3	30.2	8.5	1,125	2,550	1 All. 250-C18A ts.	150	8,200	366	LOH version.
	369C			1	6-7	26.3	30.2	8.5	1,105	2,550	1 All. 250-C20 ts.	150	12,000	375	
	369D			1						3,000	1 All. 250-C20B ts.	161	9,600	333	OH-6D version proposed for Army ASH.
		YAH-64	AAH	2							2 GE T700				Prototype attack helicopter.
Kaman Aerospace Corp. subs. Kaman Corp. Bloomfield, Conn.	K-20-2	UH-2C	Seasprite	2	10-14	44.0	52.2	13.5	7,390	11,616	2 GE-T58-GE-8B ts.	157	14,000	425	Search, rescue, utility.
	K-840	HH-2D	Seasprite	2	10-14	44.0	52.2	13.5	7,664	12,500	2 GE T58-GE-8F ts.	172	14,600	445	Search, rescue, utility.
	K-880	SH-2D	Seasprite	3	3	44.0	52.2	13.5	6,953	12,500	2 GE T58-GE-8F ts.	165	15,600	425	Lamps I helicopter.
	K-888	SH-2F	Seasprite	3	3	44.0	52.2	13.5	7,060	12,800	2-T58-GE-8F ts.	165	14,600	425	Lamps helicopter with new rotor and avionics.
Piasecki Aircraft Corp. Philadelphia, Pa.	159	Stamp	Air Geep	1	3	21'		6.9		1,850	2 CW-RC-Z 75Y-6	153	3,000	140	Liaison Transport
Sikorsky Aircraft Div. United Aircraft Corp. Stratford, Conn.	S-61D	SH-3D	Sea King	2-4	25	62.0	72.7	18.8	12,087	20,500	2 GE T58-GE-10 ts.	167	10,600	625	
	S-61L			3	28	62.0	72.7	17.0	11,792	19,000	2 GE CT58-140-2 ts.	148	8,700	265	
	S-61N			3	26	62.0	72.4	16.5	12,456	19,000	2 GE CT58-140-2 ts.	150	8,700	470	
	S-61R	CH-3E		3	25-30	62.0	73.0	16.1	13,423	22,050	2 GE T58-8 ts.	138	6,200	509	
	S-62A	HH-52A		1-5	10	53.0	62.2	10.0	4,937	7,900	1 GE CT58-110-1 ts.	101	14,100	462	
	S-64	CH-54A	Tarhe	3-5	45	72.0	88.5	25.4	19,234	42,000	2 P&W JFTD 12A-4A ts.	122	10,300	230	Unarmed-tachable van.
	S-64E		Skycrane	3-5		72.0	88.5	25.4	19,190	42,000	2 P&W JFTD 12A-4A ts.	127	10,200	230	
	S-64F		Skycrane	4		72.0	88.5	25.4	19,607	47,000	2 P&WJFTD 12A-5A ts.	115	7,200	230	
		CH-54B		3-5	45	72.0	88.5	25.4	19,000	47,000	2 P&W JFTD 12A-5A ts.	115	7,200	230	
	S-65	CH-53A	Sea Stallion	3	37	72.2	88.2	28.9	22,444	38,000	2 GE T64-GE-6 ts.	195	10,900	260	Alt. gross weight of S-65 42,000 lb.
		HH-53C		3		72.9	88.2	28.9	23,606	36,228	2 GE T64-GE-7 ts.	186	11,700	777	Range is with aux. tanks.
		CH-53D		3	37	72.2	88.2	28.9	23,485	50,000	2 GE T64-413 ts.	195	13,400	260	
		RH-53D		4	37	72.2	88.2	28.9	23,843	41,124	2 GE T64-413A ts.	195	13,400		
	S-67			2	12	56.0	65.9	15.9	7,460	13,000	1 UACL PT6T6 ts.	143	10,100	321	Kit conversion of S-55.
	S-69			2							2 UACL PT6 ts. + P&W 300 U.				Rotor tested.
	S-70	YUH-60	UTTAS	3	11						2 GE T700 ts.				
	S-72			2		62	75.9	15.5	20,81	223,99	2 Gh. T64-413 ts + 2 T134-61-2 tf.	331			Rotor systems research aft
	S-76			2	11	40.0		11.6	6,704	9,549	2 All. 250-C30 ts.	167	8,100	460	
Boeing Vertol Co. Philadelphia, Pa.	107	CH-46F	Sea Knight	3	25	51.0	84.4	16.9	12,632	20,800	2 GE T58-10 ts.	161	9,700	215	US Navy version is UH-46.
	114	CH-47C	Chinook	3	44	60.0	99.0	18.7	21,735	46,000	2 Lyc. T55-L-11C ts	190	10,000	412	
	105C			1	4	33	38.9	9.6	7,000	8,070	2 All. 250-C20 ts	167	8,900	353	License agreement with MBB—Germany
	301	XCH-62	HLH	5	12	92	162	24.7	60,340	118,000	3 All. KT701-AD-700	168	12,200	434	
	179	YLH-61A	UTTAS	3	11						2 Gh. T700				

FIGURE 2-2. U.S. ARMY OH-58A KIOWA

FIGURE 2-3. BELL MODEL 206B JETRANGER

(3) Model TH-57A SeaRanger. The Navy's version, shown in Figure 2-4, is used at Pensacola, Florida, for training purposes. Every Navy flier now receiving primary helicopter training learns his skill in the TH-57A. The 40 craft based at Pensacola are maintained by Bell Helicopter under 10-year contracts with the Navy.

As a multi-purpose aircraft, the JetRanger features a variety of subsystems; these include:

(1) Air Frame

(2) Powerplant, Fuel and Oil

(3) Rotors and Controls

(4) Transmission Drive System

(5) Flight and Engine Instruments

(6) Communications

(7) Monitoring

(8) Electrical

(9) Interior and Ventilation

In addition, the aircraft can be fitted with various accessories for its special-purpose applications. Each subsystem involves individual problems of check-out, diagnosis and parts supply, and can be taken as representative of similar systems in the same category.

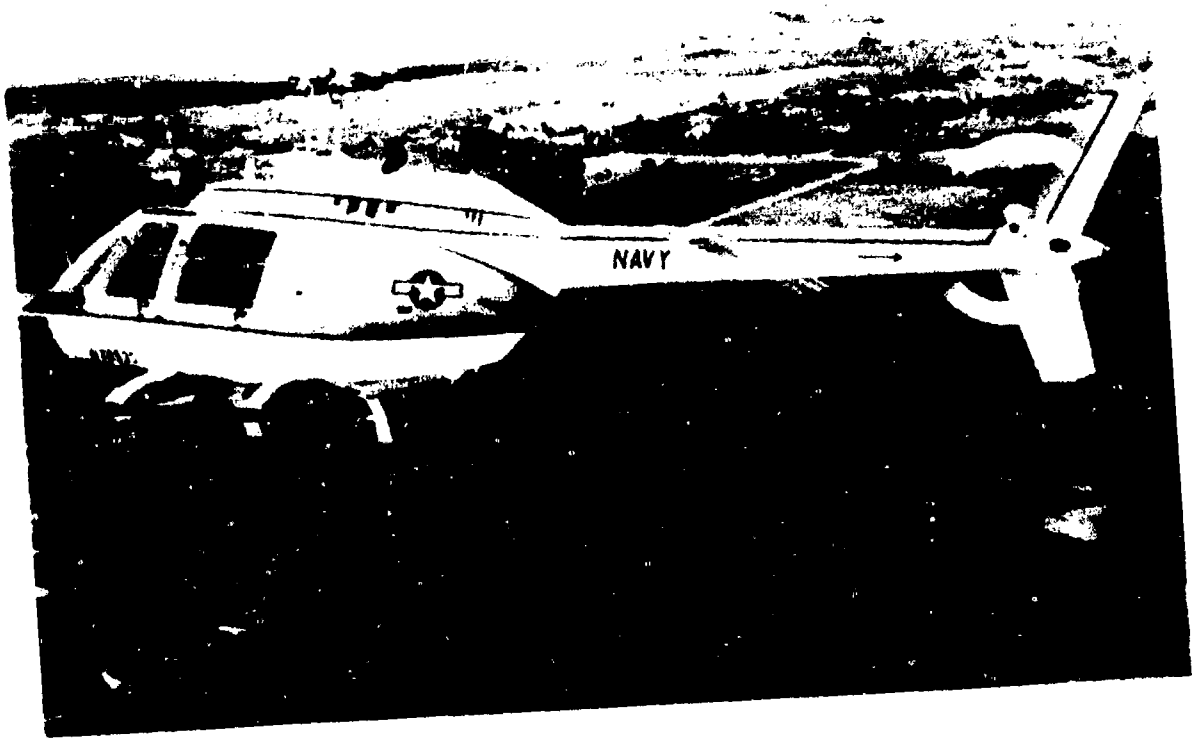

FIGURE 2-4. U.S. NAVY TH-57A SEARANGER

3. INCENTIVES AND ORGANIZATIONAL EFFECTIVENESS: A MODEL

3.1 Overview

Maintenance organizations are complex structures encompassing a multitude of factors which can potentially affect the overall effectiveness of the organization. A need exists, therefore, to structure the critical organizational and interpersonal factors in a coherent fashion to facilitate measurement and analysis. A preliminary model was developed for this purpose. An organization's effectiveness is a direct consequence of the behavior and attitudes of the individual personnel. Organizational processes, demands, constraints, incentives, philosophies, etc. impact on organizational effectiveness only as they effect the performance of the individual worker. The central focus of the model is, therefore, the primary work group composed of supervisor and maintenance personnel. The concept of "focal person" is introduced in the model to denote an individual person. Each member of the work group is, in essence, a focal person.

The model proposed is tentative, but will serve to direct attention to important variables which will have to be assessed to document comparisons between military and non-military maintenance systems. The model is not unique to maintenance organizations but is applicable to most any organization. The specific factors might change and work importance might vary but the basic model is generalizable. It is this generalizability that makes it so attractive for the proposed comparison of military and non-military organizations. A model specific to military organization would make meaningful comparisons with non-military organizations difficult and tenuous.

The basic model is illustrated in Figure 3-1. The model is divided into three main parts; organizational inputs, work unit, and organizational outputs. Organizational inputs to the work group are seen as being influenced by contextual factors outside the organization. Within the work group unit the supervisor and co-workers influence the focal person. Organizational inputs are seen as influencing each member of the work group directly as well as through interactions. Central to the model is the importance placed on the work group members' subjective perceptions of the organization and themselves. These perceptions directly impact organizational outputs.

The model is closed loop in that information concerning the organizational outputs are fed back and effect changes in the organizational inputs and the work unit. The system, itself, is an open system in that it affects, and is affected by, the outside environment.

3.2 Contextual Factors

All organizations operate in an environment. That environment (context) places demands and constraints on, and supplies capabilities to, the organization. To fully understand the "why" of an organization, it is important that its context be described. These factors become more critical when comparing military and non-military organizations because processes and functions found in one organization may be inappropriate in the other due to different contextual demands and constraints. Five principle contextual factors are included in this preliminary model; societal role, uncertainty, technology, human resources, other organizations and agencies.

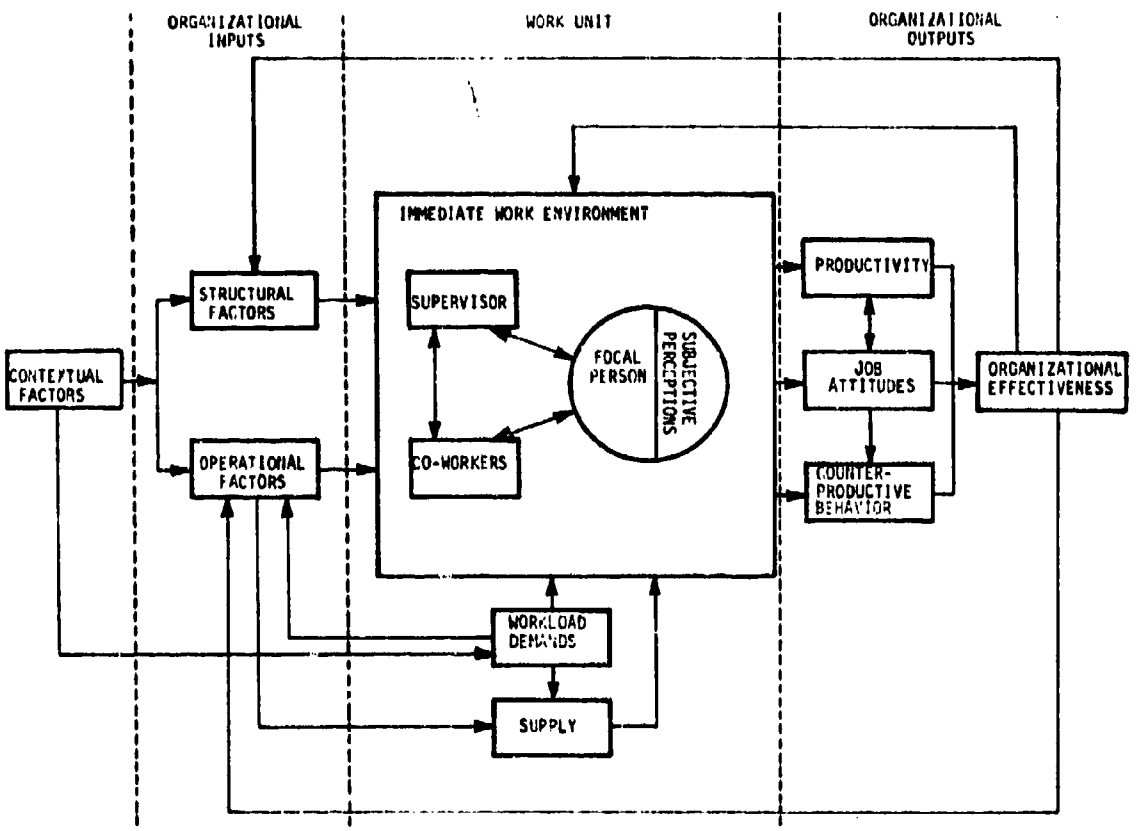

FIGURE 3-1. MODEL OF INCENTIVES AND ORGANIZATIONAL EFFECTIVENESS

3.2.1 Societal Role. The organization's function in society is based upon the organization's original charter and its primary objectives (Porter, et al, 1975). Societal roles are generally conceived of in broad terms and have been used to classify organizations. For example, Blau and Scott (1962) proposed a classification scheme based on the concept of prime beneficiary, i.e., who benefits. For example, a military maintenance organization primarily benefits the "membership", that is, the military. Some non-military organizations primarily benefit the owners and outside clients. However, a non-military police helicopter maintenance organization may be more similar to a military organization than would an airport service facility with respect to societal role.

3.2.2 Uncertainty and Complexity. Burack (1975) suggests that contextual factors can be identified by degree of uncertainty and complexity. Uncertainty and complexity refer to the consistency and predictability of the components of the environment that directly impinge on the operation of the organization. These components include such things as customer demand, manpower, supplies, and technological change.

Burns and Stacker (1961) found that very different types of management systems arose depending upon the stability of the organization's environment. With stable environments, operations and working behavior were governed by instructions and decisions issued by supervisors; a tight command hierarchy with information flowing up and decisions and instructions flowing down, almost a classic military structure. But where there was a rapidly changing environment, a more "loose" operation developed; formal definition in terms of methods, duties and power were reduced, interaction ran laterally as well as vertically, communication between people of different ranks tended to resemble lateral co-equal consultation, almost the antithesis of a classic military structure. Further, if an

organization's structure and function does not match its environment, the organization will be less effective than when structure and function match the environment (Lawrence and Lorshe, 1967).

It is important, therefore, to assess the uncertainty and complexity of the environments of the organizations studied. Suggestions for altering the military organization must take the reality of environment into consideration. Some non-military modes of operation may not be efficient for the military because of differences in their environments.

3.2.3 Technology. Technology can be defined as the "techniques used by organizations in work-flow activities to transform inputs into outputs" (Porter, et al, 1975). Chapple and Sayles (1961) term technology as who does what with whom, when, where, and how often. There is a controversy in the literature over the dominance that technology has in determining the basic operating structure and organizational characteristics. Woodward (1958) believes technology is the major determinant of structure and function. Pugh, Hickson, Hinings, and Turner (1969) on the other hand, argue that size is the major determinant. Pennow (1967) asserts that organizations cannot be compared unless their technology is similar while Hickson, Pugh and Pheysey (1969) state that there are principles that hold across organizations irrespective of task and technology. Fortunately, in the current study, this variable is being held constant by concentrating effort on the maintenance of a single type of helicopter.

3.2.4 Human Resources. The contextual factor of human resources addresses the types of people (ability, motivation, etc.) that an organization has available to it. This impacts on the functioning of the organization and its ultimate effectiveness in various ways. Availability

of human resources effects the selection, placement and training function of the organization. In addition, it impacts on the choice of control mechanisms and work structures. For example, Porter, Lawler and Hackman (1975) suggest that employees who are more educated or skilled resent tight controls, especially when activities are not well specified. Further, not providing enough structure to activities for low skill level employees can also be frustrating. Individuals with strong higher order needs (e.g., self-actualization, autonomy) prefer organizations with informal atmospheres and less structured activities; whereas individuals who do not possess these traits perform more efficiently in more structured organizations.

Military and non-military maintenance organizations differ widely in the availability of human resources. Non-military organizations can require FAA A&P licenses for its mechanics; the military cannot because they are not available in sufficient numbers. The motivation of military and non-military personnel may differ on important dimensions of need, expectations, etc., and this must be documented and considered.

3.2.5 Other Organizations and Agencies. For non-military maintenance organizations, government agencies, principally the FAA, set regulations which impact the organization. FAA maintenance requirements, mechanic license requirements, and reporting requirements, etc., all effect the operation and effectiveness of the organization. In addition to the government agencies, non-military maintenance organizations must deal with the helicopter manufacturer on such things as parts availability, service on major components, service directives, etc.

The military is also impacted by other organizations and agencies. Their budget, procedures, etc., are often decided by other parts of the military and government. The military must also deal with the helicopter manufacturer in many of the same ways a non-military operator must.

It is critical that these other organizations and agencies be identified and their impact assessed. It is possible that some incentives and disincentives for effective maintenance arise from these outside agents.

3.3 Organizational Inputs

Organizational inputs are viewed from the perspective of the work unit. The organization impacts the work unit through two major sets of factors, structural and operational. Structural factors involve the physical structure and arrangement of the organization. Structural factors include size, administrative ratio, shape, span of control, and dispersion. Operational factors involve function and process and include such factors as formalization, communication, job design, policies and philosophies, work demands, pay and promotion, and selection, placement and training. Attention to both sets of factors, structural and operational, provide the greatest understanding of behavior in organizations (Porter, et al, 1975).

3.4 Structural Factors

3.4.1 Size. The size of an organization is usually thought of in terms of the number of employees rather than other measures such as

amount of assets. Researchers have been unclear with respect to what entity was being measured: total organization; major subunits; or functional work units. The research of Pugh, et al (1969) found size to be strongly correlated with the structure of activities including specialization of roles, standardization of functions and formalization of rules and procedures. This is supported by the work of Hall, Haas and Johnson (1967). Porter and Lawler (1965) reviewed twenty-three studies and found in all but three cases that as a work group size increases, job satisfaction decreased, and absenteeism, labor disputes and turn-over increased. To compare organizational effectiveness between organizations, the size, especially work unit size, must be taken into consideration.

3.4.2 Administrative Staff Ratio. The administrative staff ratio is defined as the number of administrative (managing, supervision, foremen, clerical personnel) divided by the number of maintenance workers (Melman, 1951). This variable may often provide insight into comparisons of military and non-military organizations. Generally, the larger the ratio the greater the division of labor and the more complex the control structure of the organization.

3.4.3 Shape. Shape is defined in terms of the number of levels in an organizational hierarchy in relation to the size of the organization. If an organization has many levels in relation to its size, it would be termed tall. Another organization with few levels in relation to its size would be termed flat.

There is evidence (Woodward, 1958; Hickson, et al, 1969) that indicates that the total number of levels in the organizational hierarchy is related to the degree of technical complexity that is utilized. Kaufman and Seidman (1970) found that both tall and flat structures

existed in a sample of governmental agencies. The evidence supporting which is the best structural design, flat or tall, is sparse and inconsistent. There is evidence that suggests that in smaller organizations managers are more satisfied with a flat structure and in larger organizations they are more satisfied with a taller structure (Porter and Lawler, 1965). Here again, as with size and administrative ratio, the differences in shapes between military and non-military organizations may provide clues to differences in overall effectiveness.

3.4.4 Span of Control. Span of control is defined as the number of subordinates reporting directly to a supervisor. Large work groups do not necessarily require large spans of control. If another level of supervision (e.g., foreman) is inserted so that a few workers report to a foreman and a few foremen report to a supervisor a small span of control is achieved. In general, flat organizations have a larger span of control than do tall organizations of equal size. Span of control can have an impact on worker's feelings of autonomy. The degree of feedback given workers about their performance, the closeness of supervision afforded, and the upward flow of information affect personnel productivity and satisfaction. It is important, therefore, that the span of control be measured in each organization included in the present study.

3.4.5 Spatial Dispersion. The spatial dispersion of an organization refers to the number of spatially separated places in which the members of the organization work. Spatial dispersion is related to other structural factors. For example, the relative size of the administrative component increases as spatial dispersion increases (Anderson and Wauriv, 1961). Pugh, et al (1969) found that in dispersed organizations, the workers had more discretion in how they were to carry on their

day-to-day activities and they had more control over the work that was to be done. Spatial dispersion, therefore, must be assessed and analyzed to determine what impact it has on maintenance effectiveness. It is likely that military maintenance will be more dispersed than non-military and this could result in differences in worker attitudes and overall effectiveness.

3.5 Operational Factors.

3.5.1 Formalization. This factor deals with the extent to which rules, standards, procedures, etc. exist which indicate how activities are to be carried out. Inkson, Pugh and Hickson (1970) have developed an objective scoring system for measuring formalization by assessing the number, type, and distributions of rules, standards, procedures and documents. Current thinking (Hall, 1972; Porter, et al, 1975) is that no single degree of formalization will be appropriate for all organizations nor even for all units within the same organization. The military is noted for its high degree of formalization. This may impact on the attitudes of maintenance personnel. They may feel a lack of responsibility, autonomy and self esteem, but it may engender a sense of security and certainty. The degree of formalization may act as either an incentive, disincentive, or both. This will be explored in the present study.

3.5.2 Communication Processes. There are several dimensions to the communication process: the degree of communication, the direction of communication, existence of formal and informal channels, the quality of the communication, and the speed of the communication. Katz and Kahn (1966) identified five elements of downward communication which need to be assessed to understand the operation of that aspect of the

communication channel: (1) job information, (2) rationale for the task, (3) information regarding procedures and practices, (4) feedback regarding performance, and (5) ideology to get subordinates to accept and believe in the organization's goals. Katz and Kahn categorize upward communication into four types; what the person says (1) about himself, his performance and his problems, (2) about others and their problems, (3) about organizational policies and practices, and (4) about what needs to be done and how it can be done.

It is possible that military and non-military organizations differ in the degree to which each of the components is stressed with resultant differences in personnel attitudes and behavior. An analysis of the degree and quality of each type of communication may offer insights into the effectiveness of sources of incentives and disincentives in the organization.

3.5.3 Organization of Work. How the organization structures the work for the primary work unit is an important determinant of work unit performance and attitudes. The traditional approach to the design of jobs (Taylor, 1911) held that the job should be simplified, standardized and specialized. This type design had the expected advantages of minimal training requirements, low skill requirements and worker inter-changeability. Job design was thought of in terms of what a man can do rather than what he is willing to do (Swain, 1973). Traditional job design turned out not to have the expected economic savings due to high rates of turnover, absenteeism, grievances (Lawler, 1973) and in some cases, sabotage (Swain, 1973). Some individuals have a need for jobs that are more complex, challenging and interesting.

It is likely that military organizations organize work more along traditional job design principles than do non-military organizations. If this is so, it may suggest a possible source of incentives through

redesign of the maintenance job. Other aspects of work organization, such as hours of work, days worked, etc., may also serve as incentives or disincentives to good maintenance work and will be explored by comparing military and non-military organizations.

3.5.4 Rewards and Punishment. Rewards and punishments given by an organization include pay, promotion, recognition, transfer, demotion and termination. In the military, other forms of rewards and punishments are also possible. Not only the type and frequency of rewards and punishments need to be documented, but also the basis for administering them must also be considered. Lawler (1971) indicates that when rewards are made contingent to good performance, motivation to perform increases. An individual is likely to feel dissatisfaction if he perceives himself to have a higher input than other people who are receiving the same level of reward (Lawler, 1973). Since improper reward allocation leads to dissatisfaction and dissatisfaction leads to turnover, then extrinsic rewards may affect the decision to remain at an organization. Lawler (1973) indicates that dissatisfaction seems to cause turnover due to individuals searching for more attractive alternatives elsewhere, and because it influences the perception that the job will provide future rewards they desire.

3.5.5 Selection, Placement and Training. The selection procedures and criteria must be documented in the organizations under study. It is possible that the military, due to the contextual factor of the human resources available, may have lower selection and placement standards.than do non-military organizations. This will influence how the work is organized, the degree of formalization needed and the overall effectiveness of the maintenance organization.

Training requirements are dependent on the caliber of the personnel selected. Information concerning selection for training, amounts and degrees of training, proficiency testing, effectiveness of training, refresher training, and on-the-job training must be obtained to facilitate comparisons between military and non-military organizations. The military is noted for its extensive investment in training. It is possible, that maintenance personnel learn many skills they never use on the job. This may negatively influence their motivation and affect their performance.

3.6 Work Unit

3.6.1 The Focal Person. The focal man is the maintenance person within the work unit. His behaviors and attitudes are influenced by a variety of factors including the supervisor and the co-workers of the unit. A particular supervisor may affect performance and satisfaction through supervisory style or the control of rewards. The co-workers are also an influential factor upon the focal man because this group acts to establish work norms, as referent to compare perceptions, for informal communication sources, and interpersonal gratifications. These interactions take place within a physical work environment, which itself influences the focal man and his interactions with the other members of the work unit.

The cumulative and interactive effects of the supervisor, the co-workers, the organization inputs, and the man himself all affect the individual's subjective perceptions concerning the organization, the part he plays, and his performance. Individual's perceptions are more important than the objective reality of a situation. For example, a supervisory may be concerned about his workers, supports them and listens, but if the workers do not perceive this, they will act as if it were not

so. If their job is critical to the efficient operation of the organization, but they perceive that it is meaningless and worth little, they will behave as they perceive. Discrepencies between what is, and what is perceived often point to problems in communication.

It is for this reason that the subjective perceptions of the focal man are so central to the investigation of organizations. In essence, his perceptions of the organizational inputs, and their interactions, as well as his perceptions of the work unit and the organizational outputs, must be assessed to truly understand the nature and impact of various incentives and disincentives existing in the organization.

3.6.2. Supervisor. Supervisory style influences organizational effectiveness because it influences the motivation of the worker as well as satisfaction, turnover, and absenteeism (Lawler, 1973). Early studies of leadership (Katz, Macoby, and Morse, 1950; Fleishman and Harris, 1962) identified two major leadership patterns; task or structure-oriented and employee or consideration-oriented. Likert (1959) states that the supervisor who is supportive, friendly, and sensitive will obtain higher productivity than supervisors who are not. Katz, et al (1950) and Korman (1966) found a relationship between consideration and productivity. Vroom (1964) indicates that the amount of consideration shown by a supervisor is positively related to work unit efficiency. Other research (Fielder, 1964) suggests that the most effective style of leadership depends on situational factors. In some situations, consideration-oriented leaders get more productivity, while in other situations, task-oriented leaders get more productivity from the work group.

The supervisor influences the giving of organizational rewards and punishments and also can influence the focal man's perceptions of what rewards and punishments should be, whether they are distributed based on performance, and whether the focal person is being fairly treated.

3.6.3 Co-Workers. Co-workers of the immediate work environment contribute to the rewards and punishments received on the job. Friendly co-workers can affect overall effectiveness of the work unit. The group norms establish effort levels for the group and serve to filter perceptions of the organization and its functioning. It is possible that military work units are closer knit and interact more off the job than non-military, due to the common living conditions often encountered in the military. Work group norms may be more potent in such situations since sanctions for violating the norms can extend off the job as well.

3.6.4 Work Environment. The environment in which a man works can directly affect his performance. Environmental effects on performance are exerted in two primary ways: (1) the environment may be such as to degrade a sensory modality directly, and (2) the environment may introduce physiological stresses which indirectly affect sensory or motor performance. Some of the environmental factors that have been found to influence performance include; level of illumination (Kopkinson and Collins, 1970; McCormick, 1970), noise (Jerison, 1959; Boggs and Simon, 1968; and Eschenbrenner, 1971), and weather conditions (Fox, 1967; and Axer, MacNail, and Levny, 1972). A comparison of organizational effectiveness should take into consideration differences in work environment between organizations.

The military, when engaged in national defense, is sometimes forced to work under more adverse conditions than non-military. For the organization to be studied, the work environment will have to be described and information sought to assess its probable impact on the work unit.

3.6.5 Subjective Perceptions. The perception of individuals affects their attitudes and performance. Reality has its major impact through perceptions of the reality. The focal man's perceptions of, and attitudes about, each of the factors identified in the model and subsequently

uncovered during additional site visits, must be assessed. Comparisons can then be made between military and non-military organizations. The differences can be related to the objective reality of the situations and organizational effectiveness. In this way, incentives and disincentives can be isolated.

3.7 Organizational Outputs

3.7.1 Productivity, Job Attitudes, Counter-Productive Behavior.

Productivity is defined along two dimensions; quantity (how much) and quality (how well). Satisfaction, a job attitude, is an internal subjective state of a particular individual. Satisfaction is generally conceived as a psychological feeling of contentment resulting from receiving enough of a desired object. More recent theories of satisfaction describe it as a function of the relationship between what a person wants from the job and what he perceives it is offering (Locke, 1969), or the difference between what a person thinks he should receive from the job and what he actually does receive (Porter, 1961). The relationship between satisfaction and performance is controversial in the literature. Many psychologists felt that satisfaction caused good performance, but reviews (i.e., Vroom, 1964) of this literature showed the relationship to be weak. Lawler and Porter (1967) postulate that performance causes satisfaction because good performance produces rewards that make individuals satisfied. Satisfaction will, therefore, be correlated with performance only when performance leads to equitable rewards. Satisfaction is strongly correlated (negatively) with turnover and absenteeism (Lawler, 1973). Turnover, absenteeism, grievances, and sabotage are elements of organizational output, called counter-productive behavior, and cannot be ignored when evaluating the overall effectiveness of an organization.

3.7.2 Organizational Effectiveness (OE). OE is the extent to which an organization obtains its specified goals. The determination of effectiveness depends, in part, on how well the goals are defined and the validity of the instruments used to measure goal attainment. Productivity, satisfaction, and counter-productive behaviors are the major components in organizational effectiveness.

Various dimensions of organizational effectiveness have been identified in the literature (Campbell, 1973; Mahoney and Weitzel, 1969; Seashore and Yuchtman, 1967). The dimensions of Campbell (1973) provide a theoretical framework which encompasses the major elements foune elsewhere in the literature:

(1) Overall effectiveness--achievement of objectives

(2) Quality--quality of service or product

(3) Productivity--quantity of product or service provided

(4) Readiness--probability that an organization could successfully perform a specified task if asked to do so

(5) Efficiency--ratio of units produced to cost incurred to produce them

(6) Profit or return--percent of resources left over after cost obligations

(7) Turnover or retention--amount of voluntary terminations

(8) Absenteeism--frequency of unexcused absences on the job

(9) Morale--a group phenomenon involving extra effort, goal communicality and feelings of belonging

(10) Evaluations by external entities--evaluation by external individuals that have interacted with the organization

4. MAINTENANCE ORGANIZATIONS: A PRELIMINARY VIEW

4.1 Looking at Maintenance Organizations

The method of the present investigation is to use a "goal-free" approach to identify the structure and incentives of maintenance organizations. That is to say, we are observing the operation of maintenance organizations and listening to the member's own descriptions of the organizations prior to developing a formal description of the organizations' incentives. The intent is to produce a description which incorporates the views and objectives of the organizations' members, as well as the perspectives which may be imposed by the objectives of the research. The first step in this process of obtaining a direct look at helicopter maintenance organizations, was to identify both military and civilian helicopter users and to conduct initial site visits with selected users. The purpose of these initial site visits was to obtain an overview of helicopter operations and procedures of maintenance, to identify the formal organization of military and civilian maintenance groups, and to establish contact for subsequent visits.

4.1.1 Military Site Visits. Initial military site visits were made to the OH-58 System Manager of the Directorate for Weapon System Management of the U.S. Army Aviation Systems Command (AAVSCOM), St. Louis, Missouri, and to the 7th Infantry Division at Fort Ord, Monterey, California. AAVSCOM is responsible for management of the entire Army aviation fleet, including matters of aircraft acquisition, deployment effectiveness and utilization, cost and maintainability. The office of the OH-58 System Manager is specifically responsible for Army-wide management of the OH-58 fleet. The visit with this office provided information on Army maintenance regulations and procedures, Army-wide maintenance data reporting, OH-58 fleet utilization, and costs of ownership.

For a preliminary view of maintenance groups and procedures in a military helicopter user organization, visits were made to Fort Ord, California. Fort Ord is the home of the 7th Infantry Division, with helicopter units classified as divisional and non-divisional units. Divisional units are integral parts of the Infantry Division and perform flight operations as part of the Division's missions and activities. The divisional units of the 7th Infantry which operate OH-58A's include the following:

Unit	No. OH-58 Helicopters
• 1st Support Brigade	4
• 2nd Support Brigade	4
• 7th Infantry Division Artillery	13
• 2nd Squadron of the 10th Cavalry	10
• 7th Aviation Battalion	6

Non-divisional units are assigned to the military post rather than the division itself, and perform general flight operations associated with post activities. In addition, the non-divisional units can be called upon to support and supplement divisional units. The non-divisional operators of OH-58A's at Fort Ord include the following:

Unit	No. OH-58 Helicopters
• 14th Engineering Battalion	1
• 155th Aviation Company	9
• Headquarters, Fritzche Army Air Field	5
• Director of Industrial Operations	1

4.1.2 Civilian Site Visits. Initial visits to four civilian helicopter organizations provided preliminary observations of maintenance practices by civilian users. Considerations of maintainability in the OH-58/206 design and maintenance technical support services were identified in a visit with the OH-58/206 helicopter manufacturer, Bell Helicopter Company, Ft. Worth, Texas. Visits with the Bell Helicopter Company Service Center, Van Nuys, California, and with the Los Angeles Department of Transportation, Van Nuys, California, and Arizona Helicopters, Inc., Scottsdale, Arizona, provided information on maintenance organizations and procedures from the point-of-view of civilian helicopter users and owners.

4.1.3 Military and Civilian Fleet Comparisons. For purposes of an initial comparison between military and civilian helicopter organizations, Table 4-1 shows the primary characteristics of the respective aircraft fleets. These data are summarized from documents (AAVSCOM, 1975 and Bell Helicopter Co., 1977) and interviews obtained from AAVSCOM and Bell Helicopter Company. The maintenance cost data are apparently based on different accounting methods, thus the large difference in maintenance costs between military and civilian users remains to be confirmed.

Based on the interviews conducted and documents obtained during these initial visits with military and civilian helicopter user organizations, preliminary comparisons are made between the two organizations. The dimensions of the model described previously in Chapter 3, are used to provide a format for organizing the comparisons. Where appropriate, references to other published comparisons or discussions are integrated with the present comparison.

TABLE 4-1. OH-58A/206 FLEET CHARACTERISTICS

ARMY HELICOPTER FLEET (JUNE 1975)	
INTRODUCED FOR ARMY USE:	MAY 1969
SIZE OF FLEET:	2082
MEAN AGE/AC:	44 MONTHS
MEAN FH/AC:	760 HOURS
MEAN FH/MO/AC:	14.0 HOURS
MEAN FT/MO/AC:	37.2 FLIGHTS
MEAN FT TIME/AC:	22.6 MIN
MAINTENANCE DATA	
MMH/FH:	1.4 (APPROX)
COST/MH:	$11.60
DIRECT MAINTENANCE OPERATING COST:	$98.90/HOUR

CIVILIAN HELICOPTER FLEET (JUNE 1976)	
NUMBER OF OPERATORS:	176
NUMBER OF AIRCRAFT:	884
MAINTENANCE DATA	
MMH/FH:	.53
COST/MH:	$10.00
DIRECT MAINTENANCE OPERATING COST:	$33.23/HOUR

4.2 Objectives of Maintenance Organizations

Organizations develop to achieve specific goals and objectives. Goals and objectives are important in determining the structural and operational features of an organization. To a great extent, the differences between military and civilian organizations may be attributed to different goals and objectives.

4.2.1 Military Goals and Objectives. The primary objective of military maintenance units is to support the overall mission requirements of the parent military unit. This support objective consists of insuring that aircraft are available when required. Present Department of the Army standards require 70% availability. Cost does not seem to be a major component in the evaluation of maintenance efficiency and effectiveness. From the observations during the present preliminary analysis, it would seem that a unit would be considered effective if it maintained the 70% availability standard no matter how many man-hours were expended, parts consumed, or dollars spend, within liberal limits. Thus, it would seem that the goal of meeting established availability standards, without much concern for cost, may be a major cause of higher military maintenance costs.

4.2.2 Civilian Goals and Objectives. The primary objectives of civilian maintenance stress providing cost effective maintenance and supporting the objectives of the user organization, including maximizing profit and expansion of the market. In pursuit of this goal, civilian organizations stress efficiency rather than availability of aircraft.

Differences between military and civilian goals and objectives are most evident in the way jobs are designed, the emphasis placed on the task of maintenance, and the qualifications and skills required of the maintenance personnel.

4.3 Structure of Maintenance Organizations

4.3.1 Organizational Hierarchy. Military maintenance is organized as a hierarchical structure, with more complex maintenance activities performed by maintenance groups at higher levels in the hierarchy. Currently, five hierarchical levels are used by the U.S. Army; Operational, Organizational, Direct Support, General Support, and Depot levels. In the near future, the Army will combine Direct Support and General Support levels into a single Intermediate level between the Organizational and Depot levels of maintenance. An individual maintenance person is assigned to a work unit which performs maintenance duties of one specified level of maintenance. Normally, military maintenance personnel do not move from one level of the hierarchy to another.

Operational maintenance is performed by the operator of the equipment and includes routine, daily tasks such as visual inspections of controls and displays at the equipment operator's station. Since this level of maintenance does not include any specific maintenance training, technical manuals, or tools, the Organizational level can be considered the first level of maintenance for which specifically-trained maintenance personnel are required. Organizational maintenance includes duties of preventive maintenance, troubleshooting, and minor repair actions. These duties, performed by a crew chief, usually include general aircraft cleaning and systematic inspection to discover and correct defects before serious damage or failure occurs. Personnel of organizational maintenance units have daily contact with the aircraft, performing their maintenance duties before and after every flight. The objective of organizational maintenance is to provide operationally ready aircraft for mission support.

Maintenance at the Direct Support (DS) and General Support (GS) levels is performed in support of organizational maintenance units. Although circumstances may vary depending upon the physical locations of

the various maintenance units, DS and GS maintenance personnel do not usually have daily contact with any specific aircraft. Rather, aircraft are delivered to the DS or GS facility as maintenance needs arise for those aircraft. Activities performed at this level include repair, replacement, alignment, calibration, etc., of components or major aircraft systems. DS and GS level personnel may also be responsible for recovery and repair of downed aircraft in the field. These activities generally include those maintenance tasks which require skills or tools which are not available to an organizational level mechanic "on the flight line."

Direct Support and General Support maintenance is generally performed by uniformed military personnel of a division maintenance company for divisional units. For example, in the 7th Infantry Division, the 7th Aviation Maintenance Battalion is responsible for DS and GS maintenance of the OH-58 helicopters. However, for non-divisional units of an Army post, DS and GS level maintenance may be performed by civil service personnel through the office of the Director of Industrial Operations (DIO). DIO can also perform DS and GS maintenance services for divisional units when the latter are overloaded.

Depot level maintenance is performed off-base at a specialized repair depot. In the case of the OH-58, all depot repairs for all aircraft in the Army fleet are performed at one centralized location. Depot level maintenance includes such activities as overhaul and remanufacturing of major subsystems. In this regard, depot maintenance can be compared to civilian remanufacturing maintenance performed by an airframe manufacturer or specialized engine or transmission overhaul company. Because depot level maintenance is not performed by the user group, i.e., division or post, this level of maintenance is excluded from the present study.

Table 4-2 from the Organizational Maintenance Manual, Army Model OH-58A Helicopter (TM 55-1520-228-20), illustrates the types of maintenance activities to be performed and the maintenance level that is expected to perform each activity. The letters O, F, H, and D represent the maintenance levels of Organizational, Direct Support, General Support, and Depot, respectively. As indicated by the table, a greater percent of organization maintenance time is spent performing inspection tasks; whereas, the concentration of Direct Support and General Support maintenance effort is on repair and replacement tasks.

Civilian maintenance organizations, unlike those in the military, do not have hierarchical structures. In fact, civilian maintenance structures are centralized. That is, activities which would be performed by Organizational, Direct Support, and General Support levels in the military are all performed by a single maintenance group in civilian maintenance. This difference between military and civilian maintenance organizations is illustrated in Figure 4-1. Military personnel are assigned to one or another of the several levels, but do not move between levels. Civilian personnel work within the single maintenance level and would be expected to work anywhere within that group.

Not only are civilian organizations centralized, but also the maintenance personnel are less specialized. This lack of specialization and the centralized organization means that civilian maintenance personnel can be assigned to any task from routine inspections to repair of major subsystems. Military mechanics, on the otherhand, can only perform maintenance tasks described by their Military Occupational Specialty (MOS) and by the Maintenance Allocation Chart.

TABLE 4-2. MAINTENANCE ALLOCATION CHART

(1) GROUP NO.	(2) FUNCTIONAL GROUP	(3) MAINTENANCE FUNCTION											(4) TOOLS AND EQUIPMENT	(5) REMARKS
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	REBUILD		
		a	b	c	d	e	f	g	h	i	j	k		
	ROTOR AND TRANSMISSION SYSTEM (Cont)													
	Support Assembly, Collective	F							F	F				
	Transmission Assembly Main	O		O					F	O	D			
	Oil Pump Assembly	O							F		H			
	Input Drive Quill Seals	O							F					
	Drag Pin Assembly	O							F					
	Pylon Support	O							F	F				
	Oil Jets	F							F					
	Oil Filter Head Assembly	O							O	O				
	Temp Bulb	O							O					
	Thermo Switch	O							O					
	Filter	O							O					
	Screen	O							O					
	Valve Pressure	O							O					
	Chip Detector	O							O					
	Oil Cooler	O							O	H				
	Oil Transfer Tube	O							O					
	Tube, Filter to Cooler	O							O					
	Hoses and Lines	O							O					
	Duct Installation Transmission	O							O					
	Driveshaft Assembly Transmission	O		O					O	F				
	Seals	O							O					
	Freewheeling Assembly	O							F	F	D			
04	Valve Vent	O		O					%%					
	Tail Rotor Driveshaft Assembly	O					O	O	H					
	Disc Assemblies	O							O					
	Bearings and Hangers	O							O					
	Gear Box, 90°	O		O					O	F	D			
	Seals	O							F					
	Tail Rotor Hub & Blade Assembly	O			F_4				O_3	F				
	Tail Rotor Blades	O							F	F				
	Bearing	F							F					
	Tail Rotor Hub Assembly	O							F	F				
	Trunnion	F							F					
06	HYDRAULIC SYSTEM													
	Pump Assembly	O	O_1		O				O	F	H			
	Reservoir	O		O					O	O				
	Filter Assemblies	O							O	F				
	Filter Element	O		F_8					O					

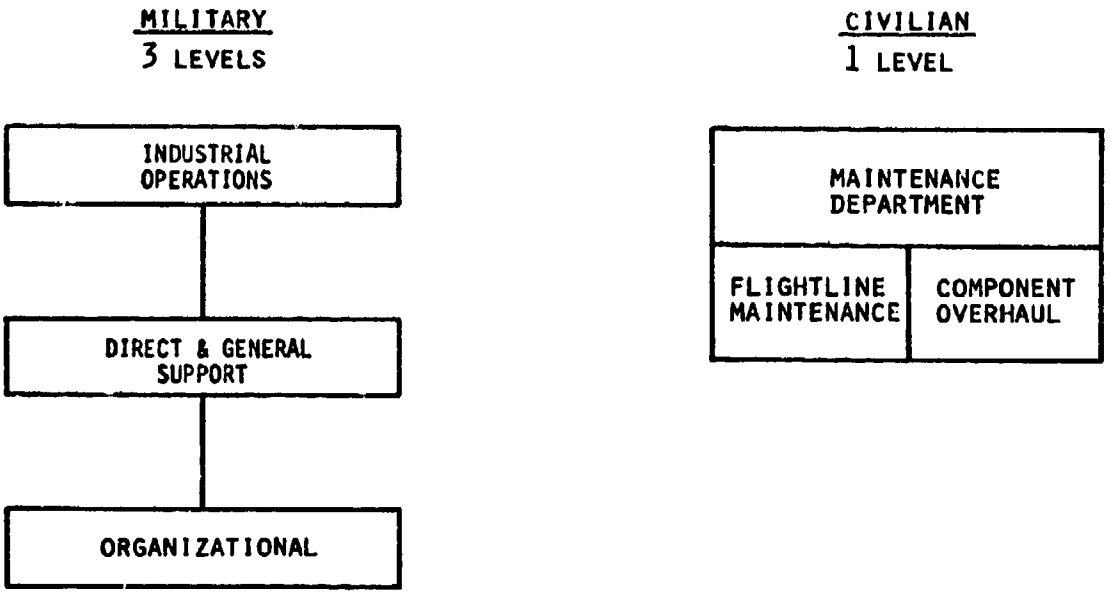

FIGURE 4-1. MAINTENANCE ECHELONS

4.3.2 Organizational Structure. Size of the functional work unit was not found to be dramatically different for military and civilian organizations. The military work unit size ranged from 25 to 115 people, while for the civilian, it ranged from 15 to 100 people. Span of control, defined as the number of subordinates reporting directly to a supervisor, for both the military and civilian, was again found to be approximately the same with one supervisor for approximately six workers. The organizational chart for a typical maintenance operation is illustrated in Figure 4-2. As can be seen, similar positions exist within the military and civilian organizations.

The shape, referring to the number of levels in an organizational hierarchy in relation to the size of the organization, is different for civilian and military units. In the civilian sites visited, there were few levels between the top and the mechanics on the line. Civilian organizations were less structured, had fewer rules and policies, and placed a strong emphasis on initiative. Observations of military operations showed the organization to be tall with many levels in the hierarchy. We found in our preliminary investigation that there were more rules and policies in the military and that perceptions of the people on top often did not match the situation on the line as described by those on the line.

One of the major differences between military and civilian maintenance organizations is the spatial dispersion of the particular maintenance activities. Civilians typically work in one centralized location and all maintenance is performed at that location. This may be due, in part, to the skill level of the available mechanics. Civilian mechanics have Airframe and Powerplant (A & P) licenses and are trained to perform all maintenance activities. Hence, all maintenance activities can be performed at one location. Military maintenance, on the other hand,

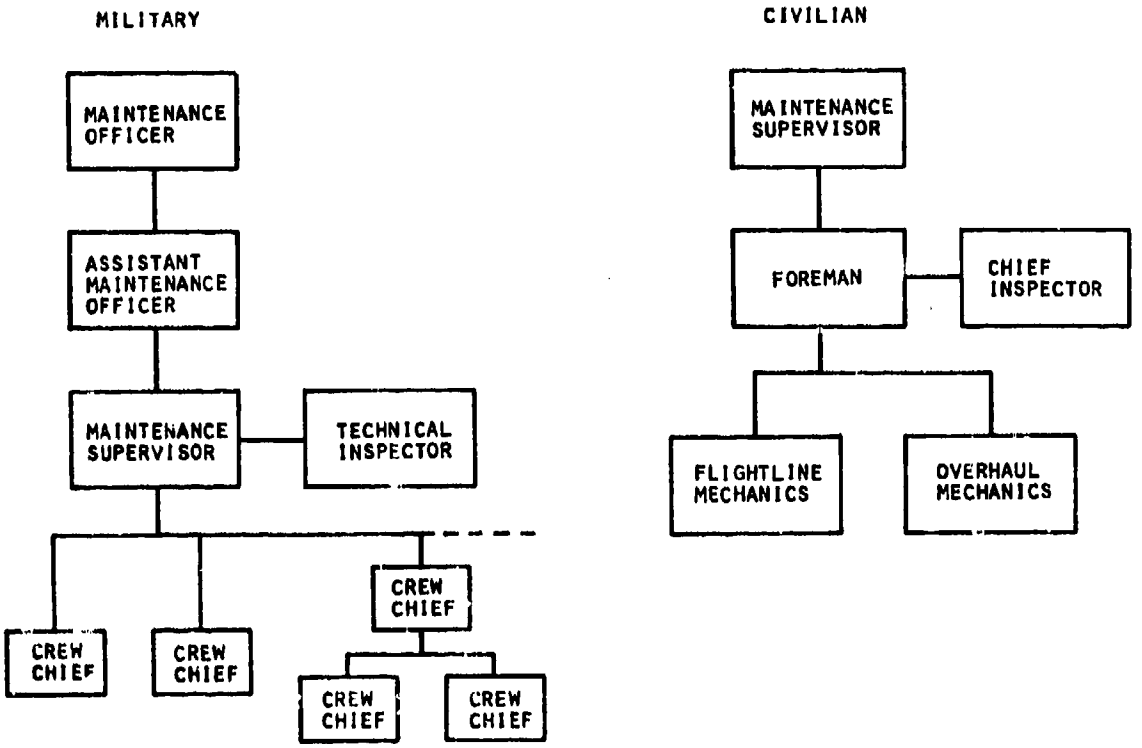

FIGURE 4-3. MAINTENANCE ORGANIZATIONAL STRUCTURE

is highly decentralized and specialized, hence each level of maintenance must be performed at a different location where the specialists are located. Furthermore, each location is governed by its own management. Therefore, instead of being one organization with three levels, it is more like three separate organizations. It is possible that the goals of each unit often conflict, resulting in an almost win-lose contest between levels. Civilian facilities, in comparison, are centralized, interrelated maintenance components working towards a single goal.

A conversation with an Organizational level maintenance supervisor illustrated the potential conflicts resulting from the military's maintenance structure. He indicated that for his unit to transfer an aircraft to a higher level of maintenance, all Organizational maintenance and paperwork had to be completed. The paperwork had to be signed by a maintenance officer whose office was located six miles from the flightline. The aircraft, along with the paperwork, was delivered to the Direct Support (DS) or to the General Support (GS) maintenance battalion. For maintenance to be performed that day, the aircraft had to be towed over before 10:00 A.M. If the aircraft arrived after 10:00 A.M., maintenance would be delayed until the next working day. He stated that on a few occasions, if DS or GS maintenance personnel discovered small, insignificant omissions in the paperwork, they would tow the aircraft back rather than calling and straightening out the deficiency or just sending back the paperwork. On several other occasions, the aircraft would sit outside the DS or GS maintenance hanger because they were out on field maneuvers.

4.4 Incentives

4.4.1 Overview. The purpose of an incentive system is to provide the worker with the greatest job satisfaction and at the same time, motivate him to work with greater efficiency to obtain organizational objectives

(Hamilton, 1964). An incentive system geared only toward increased output may not be appropriate for aviation maintenance where quality is a key factor. Therefore, an incentive system for aviation mechanics should motivate personnel to work rapidly, but maintain quality standards. Porter and Dubin (1975) suggest that an incentive system should allow for different rewards to be given to people doing the same class of work, depending on their performance. The organizational psychology literature is consistent in its directive to tie rewards directly to good performance. Lawler (1971) indicates that when rewards are made contingent to good performance, motivation to perform increases.

It is generally recognized that individual incentives are received with greater enthusiasm by the worker than group incentives. Employees in larger groups often see less relationship between their performance and the reward. It appears that the worker in the military may be evaluated more in terms of comparisons with co-workers than in comparison to set job standards.

Incentive structures can be positive or negative or both. Positive rewards include salary, promotion, bonus, overtime pay, compensatory time off, suggestion awards, shift preference, field trips, task preference, advanced training schools, and praise. Negative incentives include termination, reduction in rank, suspension, extra duty, and reprimand. Table 4-3 shows the comparisons between military and civilian incentives that were identified during the initial site visits. These incentives are discussed in the following paragraphs.

4.4.2 Military and Civilian Incentive Comparisons. Salary in the military is generally lower than that found for civilians. This is exemplified in the commonly heard platitude "you're not going to get rich in the Army, but you'll never go hungry". Military pay, ranging from entry-level to

TABLE 4-3. PERFORMANCE INCENTIVES

	MILITARY	CIVILIAN
POSITIVE		
SALARY	RANK	PERFORMANCE
PROMOTIONS	TIME IN GRADE	PERFORMANCE
PAY BONUS	NONE	YES
OVERTIME PAY	NONE	YES
COMP TIME	YES	NO
SUGGESTION AWARD	YES	SOME
SHIFT PREFERENCE	?	YES
JOB PREFERENCE	NO	SOME
FIELD REPAIR TRIPS	NO	YES
ADVANCED TRAINING	NO	YES
PRAISE	YES	YES
NEGATIVE		
TERMINATION	NO	YES
REDUCTION IN RANK	YES	NO
SUSPENSION	NO	YES
EXTRA DUTY	YES	NO
REPRIMAND	YES	YES

experienced mechanics, is approximately $900 to $1300 a month. The pay range for civilian mechanics is from approximately $950 to $1450 per month. The pay figures for military, however, do not take into account the medical, housing, commissary, post exchange, meals and other benefits. Pay raises for military personnel come through promotions, longevity, and cost of living increases. Promotions are based primarily on time-in-grade. In civilian organizations, personnel raises are based on performance, as well as cost of living increases.

Civilian supervisors motivate their personnel through other means, such as overtime pay, suggestion awards, shift preferences, choices of task, field trips to repair downed aircraft, and advanced technical training schools. In comparison, very few of these performance rewards are used by military supervisors. For instance, compensatory time is supposed to be given for working extra hours in the military instead of overtime pay. From our preliminary interviews, we found that compensatory time was accrued on the books but rarely given. Supervisors indicated that they wanted to give their man the time off they deserved, but work demands prevented it. One particular NCO said, "I still owe a man four days comp time from one year ago." This was not an isolated case, for we found this to be consistent throughout the military units interviewed. Military personnel received rewards for suggestions that save money as do civilian mechanics.

Praise was found to be used as an incentive for both military and civilian personnel, but more so for the military. We asked a maintenance officer how he got his men to work many hours, often 12 hours per day, seven days a week, and still keep them motivated. He replied by saying, "I can motivate a crew chief to work sun up to sun down by saying, 'atta

boy, you're doing a good job.'" This officer explained that he was able to do this because he believed the type of people that joined the Army are security conscious, in search of a home, and look toward officers as father figures.

For the military, negative incentives include reduction in rank, extra duty, and reprimand. Civilians use the threat of being fired, suspension without pay, and reprimand. The negative incentive common to both organizations and used most frequently, is simply a verbal reprimand. The maintenance office said that the only incentives over which he had control were of the negative type and usually in the form of "chewing a man out."

4.5 Organization of Work

Closely related to extrinsic performance incentives, the design of the job can serve as an intrinsic incentive with both positive and negative effects on a worker's performance. With regard to military organizations, the design of jobs has received more research attention than has evaluation of explicit performance incentives. Davis (1961) suggests that job designs can be classified as (1) process-centered or equipment-centered, (2) worker-centered, or (3) a combination of equipment- and worker-centered. In the first case, work tasks are specified and organized from the point of view of the job to be accomplished. That is to say, a worker's tasks are organized to maximize his output and to simplify the sequence of activities which he must perform. At the other end of the continuum, the worker-centered approach organizes the work tasks to maximize worker satisfaction and participation. The assumption of the latter approach is that high productivity will be maintained with high worker involvement in and identification with his job.

Herzberg (1968) contends that by increasing self-authority, accountability, decision making, reduction of controls, etc., workers will gain greater job satisfaction. According to this view, satisfaction is the result of responsibility, achievement, recognition, and growth. After studying Herzberg's principles of job enrichment as they apply to military crew chiefs, McIntire (1974) gave several recommendations, as follows: Each crew chief should be assigned a specific aircraft and be given a voice in making the maintenance schedule. This would alleviate shifting of responsibilities while maintaining accountability. Having crew chiefs complete the work they begin on their own aircraft would allow closure, feedback of effectiveness and increase job identity. Crew chiefs should be allowed specialized training enabling them to become experts in their field.

Using a similar approach to job design, Schwartz (1976) redesigned a Navy facilities maintenance operation aboard a ship by establishing a maintenance team, identifying tasks, development of information and work scheduling system, allocating proper equipment, and implementing a training program. Results from applying this redesign demonstrated a reduction in maintenance man-hours, improved appearance and cleanliness, and an increase in job skills and knowledge. In a related study of present military maintenance job designs, Cantrell, Hartman, and Sums (1967) found that during an average 45.4 hour work week, Air Force mechanics spent about 27.4 hours working on their primary tasks and about 11.6 hours were spent sitting around waiting for parts. The most frequently elicited comments from airmen were: (1) being kept on duty when there was nothing to do and then called in from their scheduled off-duty work, (2) the fact that they were required to do busy work, and (3) the arbitrary and unrealistic work schedules imposed. Cantrell, et al, indicated that work schedules were under the control and authority of the local commander.

The initial site visits in the present study revealed major differences in job designs between military and civilian maintenance organizations. First, and most prevalent, is the prime responsibility of the maintenance personnel. In the military, a mechanic's responsibility is to be a soldier first, whereas in civilian organizations, it is to be a mechanic. Thus, scheduling of maintenance activities in the military can be haphazard, if not impossible, because a mechanic is required to perform many duties in addition to his aircraft maintenance duties. In some instances, these other duties, such as barracks cleanups and inspections, firing range practice, gas mask tests, burial detail, race relations courses, etc., may have priority over the mechanic's maintenance duties. For example, one crew chief declared that "aircraft maintenance is something you do if you don't have anything else to do." The result of these other duties is uncertainty of schedules and delays in completion of maintenance. In this regard, one maintenance supervisor indicated that he does not know how many mechanics will show up on any particular day and that he has no control over who is called out of his company for other duties. Thus, the supervisor is deprived of a potentially powerful incentive of selecting who shall be assigned to non-maintenance duties.

The apparent lack of local control over assignment to non-maintenance duties affects not only the schedule of the overall work unit, but also the working schedule of individual mechanics. According to discussions with military maintenance supervisors, it is not uncommon to pull a mechanic off of a job to do other duties or to perform some other maintenance task. Another mechanic will then complete the original maintenance job. One mechanic said that, "all I want to do is work on my aircraft, but I hardly ever get to."

The normal working day for military personnel is 8 hours, but the day often extends upward to 12 hours. The apparent reason for the long working days is that helicopter maintenance must be completed, but because

of its apparent low priority, it is done only after other military duties have been performed. Many supervisors reported that because of time requirements of other duties, they only get about 4 or 5 hours of maintenance work from a mechanic in a typical work day. These views were supported by an evaluation of the 7th Infantry during a USAAAVS Aviation Safety Assistance visit. Results of the evaluation are as follows: "Maintenance of aircraft in the 7th Infantry is limited to 3.5 to 4 hours per day, because of a higher priority is given to other training. The fleet of sophisticated aircraft assigned demands additional maintenance time for safer operations."

The impression obtained from these initial observations suggests that scheduling markedly affects the effectiveness of a work unit. Ineffective local control of a mechanic's duties is apparently associated with (1) long working hours required to accomplish necessary maintenance, (2) mechanic's expressions of little identity with or pride in their work and, (3) duplication of effort when one person takes over an uncompleted task.

In contrast, a civilian mechanic's prime responsibility is to perform maintenance tasks. As an apparent result, the organization of work is markedly different. Rather than some days of 12 hour shifts, the normal work schedule for civilians is 8 hours per day, five days per week. In all civilian sites visited, mechanics generally finished the jobs they started. Occasionally they would be pulled off for a high priority maintenance job, but would go back to complete the first job. Extra duties performed by civilian mechanics include cleanup duties; from cleaning the cockpit bubble, to the hanger floor. However, in some facilities, managers stated that they did not think it was cost effective for mechanics to do general cleanup work, so other people were hired to perform that function.

The design of a worker's job is not only a function of the worker's defined responsibilities. The design is also affected, indeed may be dictated, by the capabilities of the workers. Thus, the skill levels of workers also determine the degree of autonomy which is assigned to an individual mechanic. As discussed in the following section, the skill level of military mechanics is less than that of civilian mechanics. As an apparent direct result of this difference, a military mechanic has less autonomy. For example, the military maintenance technical manuals give specific details for performing each maintenance operation and the mechanic is required to "go by the book." This requirement applies both to the maintenance tasks that an individual is allowed or required to perform, as well as to the procedures by which he performs a task. On the other hand, according to the publications manager of the helicopter manufacturer, civilian maintenance manuals do not include detailed procedures for performing tasks. Rather, the manuals describe the helicopter systems, parts, and functions and give special instructions regarding unusual or irregular maintenance procedures. Writers of civilian maintenance manuals assume that civilian mechanics have the experience and skills to perform most tasks with only occasional guidance from a manual. This assumption was confirmed in discussions with civilian maintenance supervisors who stated that their mechanics were expected to be able to perform all maintenance tasks on the helicopter and that they consulted the maintenance manual primarily for new or unusual procedures.

4.6 Selection, Placement, and Training

Selection, placement, and training in the military service is based primarily on the needs of the service. Thus, a person's technical specialty is largely determined by the needs of the Army at the time of selection. This is modified by several contingencies. On the one hand, the volunteer Army promises geographical location as an enlistment

incentive. On the other hand, a new enlistee may choose a career field if his Army General Classification Test scores are sufficiently high in several career areas. Additionally, as an incentive for re-enlistment, a serviceman can request a change in career field. Following selection of an enlistee's technical specialty and completion of basic training, the enlistee is sent to a technical training school to be trained in a Military Occupational Specialty (MOS). Two specialties are utilized with Army helicopter maintenance; MOS 67 and MOS 68. Maintenance activities associated with MOS 67 include preventative maintenance, troubleshooting, and minor repair actions. This is the classification held by a crew chief, who is the maintenance person at the Organizational level of maintenance. Maintenance activities at the Direct Support and General Support level are performed by persons with an MOS 68 classification. This specialty entails more specialized maintenance duties than MOS 67.

Maintenance training courses for MOS 67 and MOS 68 last for 6 to 8 weeks at the technical training school. These courses are designed to teach the basic knowledge associated with maintenance activities. Emphasis is primarily on verbal knowledge with a large portion of the instruction presented in a self-paced mode, supplemented by tutorial instruction as needed. Upon completion of technical training school, a person is still considered to be a trainee and is expected to further learn and refine his maintenance skills through on-the-job training (OJT). According to the statements of maintenance supervisors, this reliance on OJT is particularly true for hands-on experience with the helicopter.

The initial interviews with military maintenance personnel revealed several inconsistencies in the military training structure. Mechanics complained that they do not learn enough from their technical school training; the major complaint being that they did not receive enough hands-on training. Technical school course descriptions allow for some hands-on training, but apparently because of budget constraints, training

consists almost entirely of written material. A second complaint of the mechanics, as well as the supervisors, was that mechanics rarely go back for renewal training. Additional training is supposed to take place in the field through scheduled on-the-job training programs. However, the supervisors who were interviewed indicated that adequate OJT simply does not take place because they are too short of personnel to provide field training as well as perform regular maintenance duties.

Manpower assignment appears to be a problem in military maintenance units, which is closely related to scheduling and training difficulties in the units. On the one hand, a maintenance unit may have 100% of the required manpower assigned to the unit, however, other military duties take priority, resulting in less than 100% availability of needed manpower at any time. In addition, the present initial view indicates that many of the available personnel have low skill levels. Thus, a maintenance supervisor may have only a handfull of skilled mechanics who are busy performing maintenance and do not have sufficient time to show the inexperienced mechanics what to do. As a result, one supervisor said that because he cannot properly train the inexperienced mechanics, it takes 1 to 1-1/2 years before a man can work by himself constructively.

The initial site visits indicated that selection and placement in civilian maintenance organizations is very different from military organizations. Civilian organizations hire mechanics who are trained and, in many cases, have several years of experience. A requirement for employment in all civilian organizations is an Airframe and Powerplant (A & P) mechanics license which is issued by the Federal Aviation Administration (FAA), upon successful completion of a written examination and maintenance performance test. The A & P license exam is usually taken following completion of a two-year mechanics cirriculum at a technical school. A holder of an A & P license has sufficient training to perform most, if not all, maintenance d' ies associated with most

light and medium weight aircraft. The implication derived from the discussions with the military and civilian maintenance supervisors, is that a holder of an A & P license is significantly more skilled than an MOS 67 or MOS 68 qualified mechanic. In particular, an A & P mechanic is expected to be able to perform a wide variety of maintenance tasks, ranging from routine inspecions and adjustment to the repair and replacement of major aircraft systems. On the other hand, an MOS 67 or MOS 68 mechanic has training in specialized areas and is not expected to be able to perform a variety of tasks.

In terms of the desired experience level of mechanics in civilian organizations, philosophies varied among groups. In some cases, the civilian organization only hired mechanics with several years of experience, whereas other organizations would hire newly-graduated A & P mechanics. This practice is apparently influenced not only by philosophy, but also by the experience level of the available labor pool. Interestingly, all civilian maintenance supervisors stated that they would not hire personnel who had been trained by the military. They felt that the training and experience in the military is too specialized and that an ex-military mechanic would not be able to perform the full variety of required maintenance tasks. For civilian mechanics, formal training does not end with the A & P license. The initial interviews indicated that civilian organizations send their mechanics to special technical schools to learn the maintenance procedures of specific aircraft. In the case of the Model 206 JetRanger, the helicopter manufacturer conducts courses in 206 maintenance at its factory in Ft. Worth. Several maintenance supervisors stated that they use the promise of attendance at technical schools as an incentive for effective maintenance performance. In addition to off-site technical schools, many civilian organizations encourage further training through use of on-site training materials. The effectiveness of the encouragement to use these materials remains to be assessed.

4.7 Focal Person

On the basis of the preliminary investigation, it appears that differences in efficiency between civilian and military maintenance can be traced to differences in personnel, as well as to the differences in organizations that have been described above. In general, military maintenance personnel are younger, less experienced, and less skilled than their civilian counterparts. Certainly such differences can be attributed to the selection and training policies of the respective organizations. However, the subjective perceptions of the personnel are an important dimension which may contribute to each individual's effectiveness within and responsiveness to the maintenance organization. The individual's perceptions of their job and their place in the organization can be expected to influence the effectiveness of any incentives which may be used. For example, the older civilian group may value autonomy and promotions, while the military mechanics may place higher emphasis on time off, vacations, and verbal praise. The subjective perceptions of the individual mechanics remains to be assessed during the data acquisition phase of the program.

4.8 Supervision

Cantrell, et al (1967) found that poor job supervision had a major negative impact on airmen's satisfaction and intent to reenlist. Results from that study recommend that supervisors should be very carefully selected, trained, and required to personally supervise the work of their subordinates. They should interact with subordinates in such a way as to provide recognition of sound, effective work, and censure for incomplete, unacceptable, or late work. Cantrell, et al, adds that mere rank or time-in-grade should not be used as the sole criterion for selecting supervisors. McIntire (1974) emphasized the need to teach modern

management concepts in all military schools dealing with officers and supervisors. Furthermore, he posited that decentralization and trust in the lower echelons must filter down from the top military and defense leaders. Delegation of authority and responsibility to the lower echelons, he stated, may return the management functions to the levels where they can best be accomplished.

The level of supervision in this study is concerned with first level and sometimes second level supervisors, depending on the structural characteristics of a particular maintenance organization. Typical titles of these supervisory positions are maintenance supervisors, in the military, and foremen in civilian. It is possible for a civilian mechanic with less seniority, but with high technical competence and skill, to become a supervisor over someone with more seniority. In the military, supervision is based on rank which is primarily a function of seniority. Higher rank, by definition, means superordination regardless of supervisory ability. Technical competence was found to be generally very high with civilian supervisors, but was more variable with military supervisors. This seems to support previous findings regarding the differential training and supervisor selection requirements.

4.9 Organizational Effectiveness

The effectiveness of an organization is often defined differently by individuals at different levels of the organization. At this point in our investigation, we are working on the premise that there is a finite number of parameters which, when weighed and combined, yield a perception or definition of organizational effectiveness. These finite parameters can be grouped under three broad classes--productivity, job attitudes, and counter productive behaviors. It is quite conceivable that different levels in the organizational hierarchy weigh the importance of these

various parameters differently when assessing effectiveness. A policy or practice may be perceived at one level as reducing effectiveness because it negatively impacts on a parameter that is given a high importance weighting and positively impacts on a low importance parameter. At another level, however, the same policy acknowledged to have the same effects, might be considered as increasing effectiveness because at that level the relative importance weightings of the impacted parameters are reversed, the positive now outweighs the negative. One cannot hope to understand an organization unless the importance weighting of the people involved are assessed. It is conceivable also that importance weightings are not the same in civilian operations as they are in the military even at the same level. A major part of this project will be to deliniate the relevant parameters and assess the importance ratings of decision makers and evaluators at various levels of the organization.

At this juncture, we will briefly discuss the three major classes of parameters that are involved, to one degree or another, in definitions of organizational effectiveness.

4.9.1 Productivity. The Department of the Army has set standards of 70% availability for aircraft. Army Aviation Systems Command (AAVSCOM) reports that the overall Army statistics for availability is 75%. It appears that a military organization would be effective if it maintained 70% availability no matter how many man-hours were expended, parts consumed, or dollars spent. Civilian organizations are also concerned about availability, but they are also very cost conscious. Other measures of productivity are maintenance man-hour per flight hour (MMH/FH) and direct maintenance costs. Both of these measures show civilians to be more efficient. The MMH/FH for the OH-58A for the military is 1.4 hours, while for civilians it is .5 hours. Preliminary data show direct maintenance costs for the OH-58A for military to be $98.91 per flight hour, compared to $33.23 for the 206B for civilian operators.

The relative cost inefficiency of military is highlighted by the subjective impressions stated by the maintenance supervisors. Such impressions are reflected in the comment that, "If we were out to make a profit, we would be in receivership before grand opening."

4.9.2 Job Attitude. Job attitude refers to the subjective feelings of personnel about their jobs, co-workers, and work environment. It is conceivable that lower echelons in an organization are more concerned with the job attitudes of their men, while higher echelons are more concerned with the consequences of attitudes. The consequences of job attitudes are manifested in the third class of variables called counterproductive behavior. Based on the findings of our preliminary site visits, it seems that, in general, civilian maintenance personnel seem to have more favorable job attitudes than the military.

4.9.3 Counterproductive Behavior. Counterproductive behaviors include turnover, tardiness, absenteeism, grievances, work stoppage, and sabotage and appear to be negatively correlated with job satisfaction (Lawler, 1973). Recent schools of thought believe that morale operates on a separate continuum from satisfaction. The distinction between the two, for our purposes, involves descriptors for individual feelings (i.e., job satisfaction), as opposed to a group phenomena (i.e., morale).

In subsequent data collection, the generality of these initial impressions will be tested. In addition, investigations will probe the organization to discover what factors, policies, and traditions foster the current state of affairs and whether changes can be instituted to increase efficiency.

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6. APPENDIX A

Description of Program Milestones

This appendix contains descriptions of the milestones presented in Figure 1-1.

A.1 Milestones 1 and 5--Conduct Site Visits

The main purpose of this activity is to obtain support and cooperation from military and civilian JetRanger helicopter maintenance facilities. Other objectives include obtaining firsthand overviews of military and civilian maintenance and support organizations, to clarify the procedures required to access these systems, and to determine the type and amount of presently available data.

The initial site visits (Milestone 1) were made to Bell Helicopter Company, Forth Worth, Texas, and to the U.S. Army OH-58 Weapons System Command, St. Louis, Missouri. The purpose of these visits was to obtain program support from Bell Helicopter and from the Army. Later site visits (Milestone 5) were made to obtain specific information on the functioning of military and civilian helicopter maintenance facilities and to obtain sufficiently large sample sizes which will permit meaningful comparisons and analysis.

A.2 Milestones 2 and 8--Develop Maintenance Model

The objective of this activity is to provide a structure for identifying and investigating the relationships between key organizational factors and individual maintenance personnel productivity and satisfaction, as well as organizational effectiveness. The preliminary model

(Milestone 2) will be developed from the information gathered in the preliminary site visits, and from the literature obtained from the literature review. The information obtained from the later site visits and from late arriving literature, will be used to revise and finalize the model (Milestone 8).

A.3 Milestones 3 and 4--Conduct Computer-Based Literature Reviews

The purpose of this activity is to identify key organizational factors that relate to maintenance personnel performance and satisfaction, and to identify measures of individual and system performance.

To obtain the required data, several computer-based literature reviews were performed. The Defense Documentation Center's (DDC) database was searched to obtain abstracts on relevant government supported research. Literature reviews were conducted in the areas of organizational factors in maintenance, organizational theory, and in Israeli maintenance practices. A computer-based search on organizational factors in maintenance was also conducted on non-government databases (American Psychological Association (APA), ERIC, Smithsonian Science Information Exchange (SSIE), and American Business Inventory (ABI)). These literature reviews resulted in nearly 1000 abstracts. The abstracts have been reviewed and relevant documents have been ordered. The results of this leterature review will provide inputs into the maintenance model and to the development of the data collection instruments.

A.4 Milestones 6 and 7--Identify Civilian and Military Maintenance Procedures and Performance Measures

The objective of these tasks are to provide preliminary information on military and civilian organizational policies and effectiveness. The

information derived from the activities will provide inputs into the development of the maintenance model, questionnaire development, and the analysis plan.

A.5 Milestone 9--Select Data Sites

The objective of this activity is select representative military and civilian sites in which to collect comparative field data. Factors used in selecting sites will include: (1) the willingness of the maintenance unit to cooperate and support our research, (2) the number of helicopters maintained at the site, and (3) the type of maintenance performed at the site. The selection of sites will provide an input into developing the data analysis plan.

A.6 Milestone 10--Develop Analysis Plan

The objective of this activity is to define and document the plan for data acquisition, including the military and civilian groups to be visited, the type and number of personnel to be surveyed, and the planned data analysis procedures. The analysis plan will be balanced to insure the greatest amount of useful data is acquired within the restraints of time, budget, and group accessibility. The program plan will be submitted to the contract monitor for review prior to its execution.

A.7 Milestone 11--Develop Data Collection Instruments

The objective of this activity is to develop data collection instruments that will permit the acquisition of equivalent data on key organizational factors and performance measures for the maintenance groups surveyed. Information obtained from the site visits, the literature review, and from the maintenance model will be used to develop the data collection instruments.

A.8 Milestones 12, 13, and 16--Obtain Information on Israeli Maintenance Practices

The purpose of this activity is to acquire data on equivalent organizational factors in Israeli military maintenance organizations. The Israeli's have demonstrated a high degree of responsiveness and initiative in performing their maintenance. It is believed that the identification and analysis of Israeli maintenance practices will provide insights and innovative approaches, that if implemented in the U.S., will improve the effectiveness of military maintenance. Data on Israeli maintenance practices will be obtained by conducting literature reviews, both in the U.S. (Milestone 12) and in Israel (Milestone 13), and by a subcontract to Perceptronics Israel, Ltd (PIL) (Milestone 16). PIL will perform the review of the literature in Israel and prepare a report on Israeli maintenance practices.

A.9 Milestones 14, 17, and 23--Complete Quarterly Progress Reports

The progress reports will contain the results of the contract activities completed or in progress, for each respective quarter. The first progress report (Milestone 14) will contain the results of the activities performed in the first two quarters of contract activity. A program overview, a model of incentives and organizational effectiveness, and a preliminary analysis of maintenance systems, both military and civilian, will be presented in the first progress report. The second progress report (Milestone 17) will contain the analysis plan, including the sites to be visited, the personnel to be surveyed, the type and amount of data to be collected, and the data collection instruments. The results of the Israeli maintenance analysis will also be presented in the second progress report. The final progress report of the calendar year (Milestone 23) will contain a summary of work completed in the first

contract year. Emphasis of the final report will be placed on summarizing the comparative field data and developing hypothesis to be tested in the second year of the contract. A detailed program plan for the second year's effort will also be described in the final report.

A.10 Milestone 15--Obtain Data

The objective of this activity is to acquire data on organizational factors, incentives, and the cost-effectiveness of maintenance from the sources identified in the data acquisition plan.

A.11 Milestones 18 and 19--Analyze Data

The intent of this event is to integrate the results of the initial site visits, the comparative field survey, and the study of Israeli practices to identify and describe critical points of organizational effectiveness in U.S. military and civilian maintenance. Emphasis will be placed on system performance evaluation and on specific problem areas and causes.

A.12 Milestone 20--Identify Experimental Locations

The purpose of this activity is to identify sites and to obtain permission in which to conduct experimental evaluations of the hypotheses generated in the first year of the contract. These experimental evaluations will be conducted in the second contract year.

A.13 Milestone 21--Develop Experimental Hypotheses

The data obtained from the comparative field data and the data obtained from the analysis of Israeli maintenance practice, will provide inputs into developing experimental hypotheses. The hypotheses,

alternative approaches for increasing the effectiveness of military maintenance, will be tested in the second year of the contract.

A.14 Milestone 22-Develop Program Plan for Second Year

The purpose of this activity is to establish a plan for a detailed examination of the critical and innovative organizational approaches identified in the data analysis and from Israeli maintenance practices. Recommendations will be made for the application and experimental evaluation of a selected number of approaches that are likely to have high payoff potential.